WHEY EVERY ASPECT

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1. INTRODUCTION

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1.1. Milk Components and Nutrients

Milk is defined as porcelain white biological liquid with a unique taste and smell produced by the mammary glands of mammals for a certain period of time depending on the type of animal, which includes all nutrients that the infants need until they grow old to feed themselves on their own, at the needed ratios. The legal definitions, on the other hand, also include the nutrients that the milk should have as a human food. According to the Turkish Raw Milk Standard (TS) No. 1018, milk is defined as white or cream liquid with its own unique taste and texture that is produced by the mammary glands of cows, sheep, goats and cattles, which is not mixed with other liquids and from which no nutrient is extracted. According to the Turkish Food Codex, raw milk is the liquid produced by mammary glands of one or more than one cow, goat, sheep or cattle except for colostrum, which is not heated over 40ºC or not processed with a similar process.

Milk is named after the mammal from which it is milked such as cow milk, cattle milk. Since the cow milk is the raw material of many products including primarily the drinking milk, the cow milk first comes to the mind when someone says “milk”. The type of milk consumed changes depending on

the culture of the societies in which it is consumed. However, although the cow milk first comes to the mind in Turkey when someone says milk, there are 4 types of milk: cow, sheep, goat and cattle. The milk produced from cow, cattle, sheep, goat, camel etc. is used in human diets. The nutrients of the milk change depending on the type of animal from which it is produced. The cow milk is the most consumed milk in the world. The cow milk comprised of 88% of water in average includes more than 100 components. Milk and milk products are good source of protein, calcium, phosphorus, vitamin A, some vitamin Bs (especially riboflavin, B_{12} vitamin). Milk is produced right after birth and this first milk is called the colostrum. Colostrum is richer in nutrients compared to the normal milk. The immunoprotective materials in colostrum are very important. The milk is comprised of milk sugar (lactose), milk fat, milk proteins, minerals and vitamins.

Milk has a high ratio of water and is the mixture of fat, casein, lactoglobulin, lactalbumine and lactose and mineral materials that pass through blood via tissues. Milk includes more than one hundred and thousand molecules

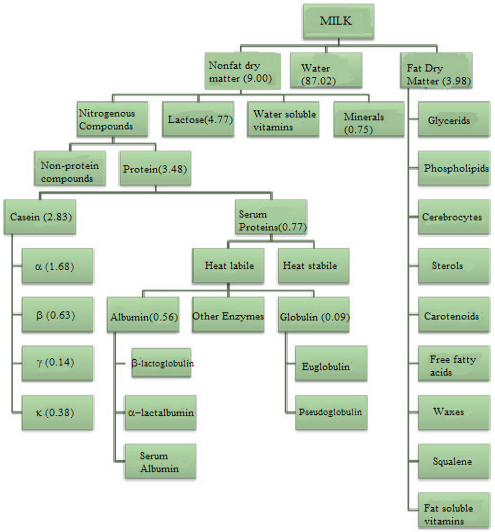

Figure 1.1. The milk ingredients and their percentages

The milk ingredients are fat globules in the form of emulsion, colloidally dispersed proteins (caseins) and soluble lactose and soluble proteins. Moreover, various minerals, vitamins, enzymes, organic compounds and gas are other milk ingredients. The milk ingredients differ depending on the type and breed of animal. The general ingredients of different animals are shown in Table 1.1.

Table 1.1. Average chemical composition of cow, sheep, goat and cattle milk (g/100 g milk)

Composition	Cow milk	Sheep milk	Goat milk	Cattle milk
Water	87.5	81.7	86.9	82.5
Fat	3.6	6.9	4.0	7.9
Lactose	4.7	4.8	4.6	4.5
Protein	3.3	5.6	3.6	4.2
Minerals	0.9	1.0	0.9	0.9

Table 1.2. Average components for cow milks from different breeds (g / 100 g milk) (Hui, 1993).

Breed	Fat	Protein	Lactose	Ash	Total dry matter
Holstein	3.54	3.29	4.68	0.72	12.16
Ayrshire	3.95	3.48	4.60	0.72	12.77
Guernsey	4.72	3.75	4.71	0.76	14.04
Jersey	5.13	3.98	4.83	0.77	14.42
Brown Swiss	3.99	3.64	4.94	0.74	13.08

Milk is one of the fundamental foods of human beings in terms of chemical components and characteristics and includes most of the materials needed for nutrition.

Milk proteins are an important source of essential amino acids (that cannot be synthesized in the human body) and include them at a sufficient and balanced level. They even include some essential amino acids (for instance lysine) more. Therefore, dairy products improve the biological values of some food (for instance, flour, corn, potato) if they are eaten together. Milk and milk products include balanced levels of essential (isoleucine, leucine, lysine, methionine, phenylanine, threonine, tryptophan, valine, partially histidine and arginine) and nonessential (alanine, aspartic acid, cystine, glutamic acid, glycine, proline, serine, tyrosine) amino acids that form the protein structure. Lactose, whose only source is milk, is of great importance in terms of nutrition physiology. That is because lactose plays a role in the formation and protection of natural microflora of the intestines; since it digests slowly, it affects the functioning of the intestines positively and prevents fast increase in the level of blood glucose. Lactic acid produced after lactose decay increase the absorption of calcium and magnesium in the intestines and decreases the fat accumulation

in the liver. Cow and sheep milk include around 4.5% of lactose. Since it dissolves in water, it penetrates into whey. Therefore, lactose is produced from whey. Lactose is digested by some microorganisms and causes increase in acid level of milk. In addition to being a rich source of energy, milk fat includes significant amount of fat-soluble vitamins (vitamin A, D, E, K) and essential fatty acids (linoleic, linolenic and arachidonic). They play a significant role in the formation of desired taste and structure in milk and milk products. Moreover, milk fat is digested more easily due to high amount of short and medium chain fat acids in its structure. Carotenoid pigments contribute to yellowish colour of milk fat while riboflavin pigments give a fluorescent colour to the milk fat. As the milk fat decreases, the amount of dissolved vitamin content also decreases. Unenriched milk includes remarkably low levels of vitamins D and K. Milk also includes water-soluble vitamins. It is considered as a good source of folate since it has folate-binding proteins that increase absorption and serum proteins. However, despite its high vitamin content, uncontrolled heat treatment might decrease vitamin content.

In terms of mineral materials, milk is the most important source of calcium and phosphor and includes these materials at the desired level. Except for butter, it is not possible to satisfy the calcium need of the body (800 - 1200 mg) without consuming milk and milk products. Milk is also a good source of milk, magnesium, potassium, zinc etc. The mineral content of milk is affected by several factors such as physiological conditions of the animals, lactation conditions, environmental factor and genetical factors, some processes on milk.

Table 1.3. Average ingredients of raw milk (in 100 g of milk)

Ingredients	Energy (kcal)	Fat (g)	Protein (g)	Lactose (g)	Water (g)
Amount	69	3.8	3.3	4.8	87.2

Essential amino acids	Tryptophan	Phenylanine + Tyrosine	Leucine	Isoleucine
Amounts (g)	0.05	0.35	0.34	0.21

Essential amino acids	Threonine	Methionine	Lysine	Valine
Amounts (g)	0.17	0.12	0.27	0.22

Minerals	Ca	P	Mg	K	Na	Cl
Amounts (g)	0.12	0.10	0.12	0.15	0.05	0.10

Vitamins	Vit.A (mg)	Carotene (mg)	Vit.B1 (mg)	Vit.B2 (mg)	Vit.B6 (mg)
Amounts	0.06	0.02	0.04	0.17	0.05

Vitamins	Vit.B12 (µg)	Niacin (mg)	Panto-thenic acid (mg)	Vit.C (mg)	Vit.E (mg)
Amounts	0.50	0.09	0.36	2.0	0.12

1.2. Production of Cow's Milk

According to the data annually published by the Food and Agriculture Organization of the United Nations (FAAO), the total number of cattle in the world increased by 0.9% in 2012 compared to the previous year and amounted to around 1.5 billion.

Table 1.4. Number of milk cows in EU, USA and Turkey (million) (FAOSTAT, 2015)

Origin	2008	2009	2010	2011	2012
EU	24,193	23,658	23,107	22,868	23,028
USA	9,315	5,431	9,119	9,194	9,223
TURKEY	**4,080**	**4,133**	**4,384**	**4,761**	**5,431**

Cow milk comprises 83% of the total milk production amount in the world. The production increased by 2.7% in 2011 compared to the previous year while the production increase in 2012 amounted to 2.1%. The total cow and cattle milk production increased by 2.6% to 739 million tons in 2012. 54% of total cow and cattle milk in the world is produced in Asia and Europe. According to FAO estimations, the total milk production amounted to 738,9 million tons and increased by 2% to around 754 million tons in 2012.

Table 1.5. Leading Countries in Production of Cow's Milk (2012)

Country	Production (mil tons/year)	Production Increase (%)
EU-27	152.0	0.0
USA	90.9	2.1
India	60.1	4.7
China	37.4	2.4
Brazil	33.7	2.0
Russia	31.9	0.9
New Zealand	20.6	8.5
Turkey	**16.0- 18.0** (2014)	15.8
Pakistan	13.9	3.8
Argentina	11.7	1.2
Mexico	11.3	2.1
Ukraine	10.1	2.6

As can be seen from Table 1.5., European countries take the top places with milk production of 152 million tons and USA, India, China, Brazil, Russia, New Zealand, Turkey, Pakistan, Argentina, Mexico and Ukraine are among the top 12 countries with the highest milk production. According to FAO researches, the milk production of Brazil, China and India has increased regularly while the milk production in EU and USA has been relatively lower.

Table 1.6. World Milk Production by Species (million tons) (FAO, 2014).

Species	2006	2007	2008	2009	2010	2011	2012
Cow	561.7	573.8	585.1	586.2	597.6	612.7	625.7
Sheep	9.2	9.1	8.9	9.4	9.8	9.9	10.1
Goat	15.1	15.9	16.1	16.4	17.2	17.6	17.8
Cattle	81	84.2	85.4	88.3	92.2	95.6	97.4
Total	668.8	685.1	697.7	702.3	719.2	738.9	753.9

According to FAO data, it was reported that milked animal number increased compared to the previous year, dairy cattle number increased by 0.9 % and milk sheep number increased by 1.5 % compared to the previous year. The facts that increase in total milk production rate in the world is more than increase in number of milked animal can be explained by the fact that milk yield has increased.

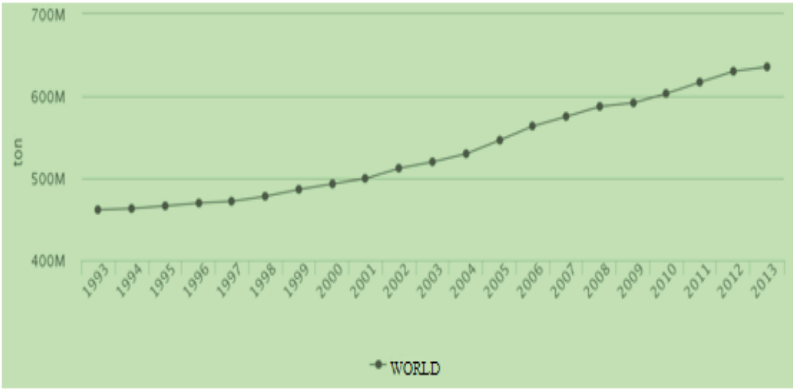

Figure 1.2. Production rates for cow milk in the world by years (M: million) (FAO, 2014).

Plant number for dairy sector and cattle plants in Turkey is quite high compared with other countries. However, it is clearly understood that there are a great number of small scale plants for dairy cattle if capacities of plants are classified according to cattle number owned by them. Dairy cow number per farm in EU countries is 32.2 on the other hand this value in Turkey is 4.5 in average. 76.3% of dairy plants have animals between 1 and 10 on the other hand 98.38% of plants consist of farms having animals less than 50. The fact that plants are small-scale in accordance with animal population they have leads to too high input costs, difficulties in supplying cattle breeds having high milk yield, difficulties in marketing milk and dairy products and organization to provide efficiency and productivity of dairy cattle raising in common sense. According to TÜİK (Turkish Statistical Institute) data, production amount for drinking milk in our country in 2013 has been calculated as 1.323.942 tones.

2. DAIRY WASTEWATER AND WHEY

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Dairy wastewater includes also chemical residues used during cleaning process as well as materials such as proteins, salt, fat components and lactose. Characteristics of released wastewater also differ depending upon production methods and types of system since many different products are produced in dairy industry. Dairy industry in Europe constitutes the greatest industrial waste water source. Any typical dairy plant located in Europe releases 500 tons of waste water per day. Whey is utilized as a privileged waste among waste water of dairy sector. Whey (W) is one of the most significant residues of dairy technology. Generally, it is yellowish, green coloured liquid remaining as a result of separation of curd during cheese production and lactose solution containing protein and minerals.

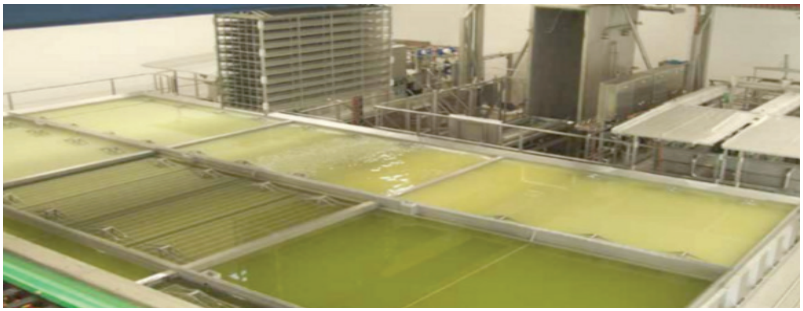

Photo 2.1. Whey releasing during cheese production.

Whey interrupts biological processes for traditional waste water treatment due to the fact that it has high biological oxygen demand (BOD) (40000-60000 ppm). It leads to very serious environmental pollution problems in long term to release whey into nature.

2.1. History of Whey

Whey has been discovered 3000 years ago. It has been utilized getting used for therapeutic purpose. In 1749, in Zurich, Switzerland; a patient whose treatment is impossible o get done and for whom doctors give very short time to live has travelled to chalet in Gais and achieved healing disease drinking whey every day. It is not known clearly whether this patient learns therapeutical property of whey by the fact that it has been known as “therapeutical water” by ancient Greek doctors or he has used it at the recommendation of peasants in that region. However, the fact that news about this patient achieving to survive despite terrific diagnosis of doctor get around in a short time has led many patients to come to Gais in order to utilize miraculous healing feature of whey. A health centre has been founded in this small village in a short time

and following that, health centres more than 160 have been founded in Switzerland, Austria and Germany. It is known that these centres have functioned in the most active way between the middle of 18th century and 19th century.

Reputation of therapeutical property of whey has spread in ashort time and it has led emperors, princes and aristocrats from all around Europe to come to these centres in order to either solve their disorders or improve their general states of health. It is the most confusing point on whey that its therapeutical property has been discovered in ancient ages and modern scientific researches also support data in ancient ages. Hippocrates (B.C. 466-377), father of medicine, advised whey to his patients. Following him; Galen (A.C. 131-200), another remarkable name of medical science, has also made recommendations to his patients about whey. Besides, whey therapy has been recommended by also other famous and remarkable names in history of medicine. Ibn-Sina (A.C. 980-1037) who has almost 200 works, Thomas Sydenham (1624-1689) known as "English Hippocrates", famous Dutch doctor; Hermann Boerhaave (1668-1738) whose clicinical education methods are used all around Europe are only a few of the names.

2.2. Legislative Regulations Related to Use of Whey

Environmental impact assessment (EIA) means and expresses activities to get maintained in determination of possible positive and negative effects of projects planned to get performed in environment, assessment of measurements to be taken to prevent negative effects or minimize in such a way not to damage the environment, selected location and technological alternatives being determined, and monitoring

and supervision of project applications in accordance with Environmental Impact Assessment Regulation conducted by T.R. Ministry of Environment and Urbanization. Any project on which decision of "EIA is necessary" is made prepares a report on special format. List of projects that will apply EIA is given in Annex-1 of the same regulation. Accordingly, dairy processing plants whose raw milk processing capacities are 100.000 litres/day and more take place in projects to which EIA is to get applied.

2.3. Release of Whey During Cheese Production

Caseins known as basic milk protein curdle when fresh milk is left to get boiled at a temperature not low and it is called "curdle" colloquially. A gel structure emerges and is seen if a mixing or shaking is not made in the following period. Whey separation is generally observed when gelled milk is held. This event can get accelerated by heat treatment application and mixing. Then, the structure is divided into two groups as curd and whey. It constitutes the basis of cheese making. However, milk has been coagulated for centuries using materials such as rennet enzyme (rennet) obtained from calf stomach. Casein and fat are in concentrated form but other milk components pass to whey within water when milk is processed into cheese.

Basic production steps required for all types of cheese can be ranged as below;

• **Coagulation process of milk:** Rennet enzyme or acid or both of them are used herein. A gel structure emerges in this period, which is formed by casein proteins that gather in a network structure surrounded by fat globules.

• **Separation of whey:** Water and water-soluble components in gel structure move away from the structure in this period.

• **Acid formation**: A certain part of lactose transforms into lactic acid.

• **Salting**: It is performed using NaCl.

• **Ripening**: It is required for desired flavour of cheese and formation of its structural properties.

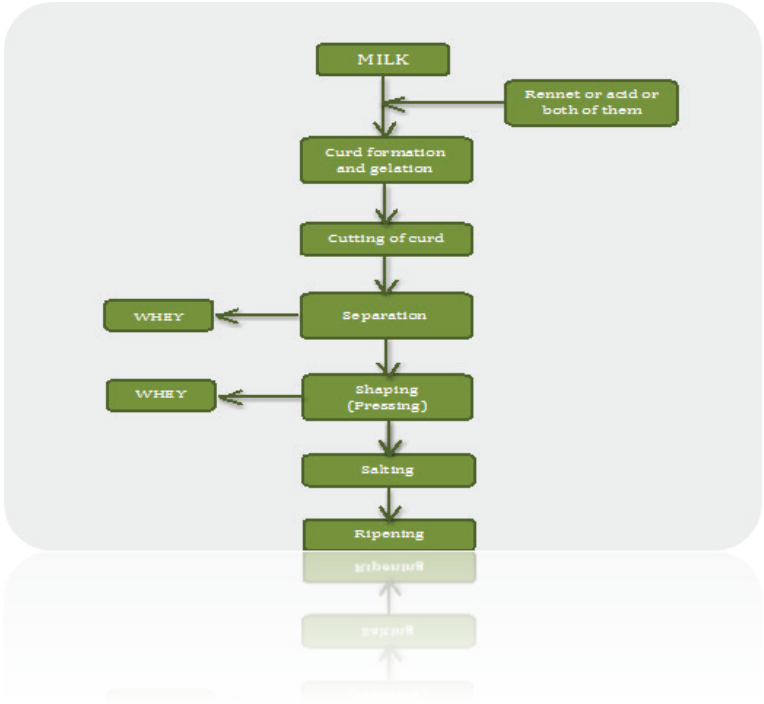

Figure 2.1. General flow diagram for cheese production and release of whey (Walstra et al., 1999).

2.4. Release of Whey during Casein Production

Casein is defined as a protein product obtained through curdling, leaching and drying process of skimmed milk. There are two types of industrial casein. One of them is "Acid Casein"

produced curdling skimmed milk using mineral acid or lactic acid. Another one is “Rennet Casein” obtained by curdling skimmed milk within rennet enzyme (rennet).

Whey (or serum part) separates from curd just after casein is coagulated by acid or rennet enzyme. This separation can be performed using one of different methods below;

- Sieves can be used, which is made of fine porous stainless steel,
- Inclined sieves made of polyester can be used,
- Mechanical devices such as centrifugal separator can be used.

Figure 2.2. Release of whey during manufacturing of acid and rennet casein curd from milk (Gürsel, 2001).

2.5. Whey Types and compositions

Whey has two types called as sweet whey and sour whey in accordance with form of manufacturing.

1. Sweet whey: by-product obtained after milk is curdled using rennet type enzymes basically around pH 5.6.

2. Sour (acidic) whey: Acid whey is by-product emerging as a result of the fact that milk is soured at and below pH 5.1.

Whey is a diluted liquid. It contains total dry matter around 6%. Whey corresponds to almost 85-95% rate of milk volume and contains almost 55% rate of milk components. Whey is a significant by-product containing proteins such as lactalbumine and lactoglobulin; milk components, and lactose, fat, mineral matter and vitamins in variable levels. Materials and amounts included in sweet and sour whey are shown in gram/liter (g/L) on Table 1. **Table 2.1.** Compound for whey (g/L)

Component	Sweet whey	Acid whey
Total solids	63.0- 70.0	63.0- 70.0
Lactose	46.0- 52.0	44.0- 46.0
Protein	6.0- 10.0	6.0- 8.0
Calcium	0.4- 0.6	1.2- 1.6
Phosphate	1.0- 3.0	2.0- 4.5
Lactate	2.0	6.4
Chloride	1.1	1.1

Principal proteins included in whey are β-lactoglobulin, α-lactalbumine, glycomacropeptide (GMP), lactoferrin, bovine serum albumin (BSA) and immunoglobulins. They are called as “whey proteins” or “whey proteins”. Whey proteins are the proteins having the highest nutritive value

compared with other food proteins. It is indicated on Figure 2.3 that whey proteins have quite high biological value and more value in almost 15% rate than biological value of egg proteins. Additionally, it is also indicated and observed that whey proteins are rich sources for basic amino acid compared with other food proteins. (Figure 2.4.).

Whey proteins have remarkable nutritive and physiological effects. *They are ranged as (i) physical performance, recovery after exercise and prevention of muscular atrophy, (ii) satiety and weight management, (iii) cardiovascular health, (iv) anti-cancer effects, (v) care and treatment of wounds, (vi) management of infections, (vii) baby feeding and (viii) healthy ageing*.

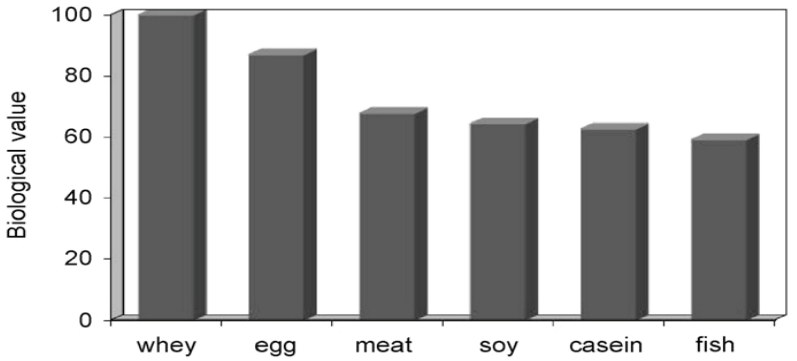

Figure 2.3. Biological value of whey in comparison with some food proteins (Smithers, 2008).

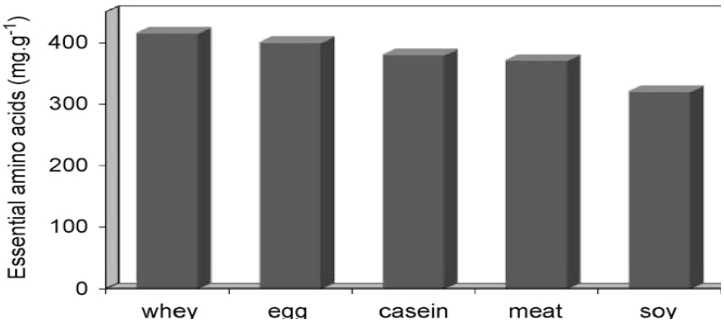

Figure 2.4. Basic amino acid ingredients of whey in comparison with some food proteins (Smithers, 2008).

2.6. General Aspects of Whey Industry

In accordance with a general rule, 9 liters of whey release during 1 kg of cheese production. It has been determined that whey production all over the world is more than 160 tons within rate of increase of yearly 1-2%.

Considerable part of whey is processed into whey powder; remaining part is processed into products such as sweet whey powder, demineralised whey, delactosed whey, whey protein concentrate (WPC), whey protein isolate (WPI) and lactose. Products such as WPC and WPI are used in pharmaceutical and cosmetics sectors. General information on liquid whey process, produced whey products and use areas have been shown on Figure 2.5.

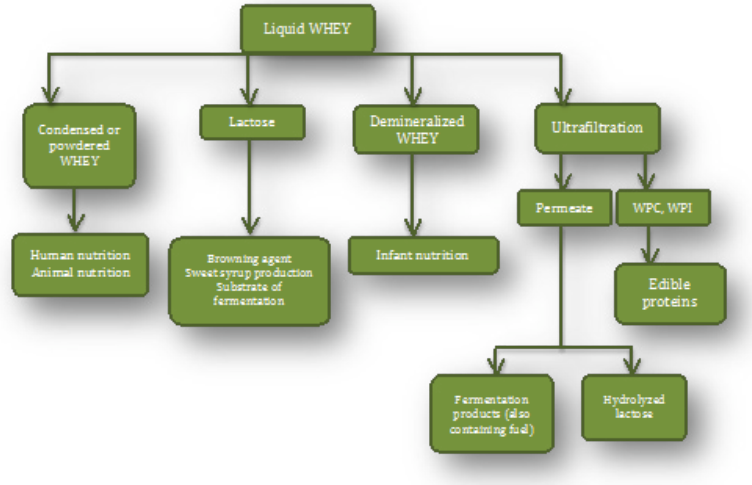

Figure 2.5. Liquid whey process (Tunick, 2008).

Whey protein ingredients are added into various foods within functional and nutritional reasons. For example, they are used in various products; primarily in sports drinks for high quality protein supplement. Whey contains water in almost 93% rate and protein in almost 0.6% rate. WPC contains protein between rates of 25 and 80%, and WPI contains protein in rates of 90% and more. 1 kg of WPI powder is produced from 150 kg of whey using various processing methods and at least 149 kg of water and water-soluble material remain. Membrane separation methods used in production of WPC and WPI, and conducted under pressure can be ranged as reverse osmosis, ultrafiltration (UF), microfiltration (MF) and nanofiltration (NF). Membrane processes conducted under electrical field are electrodialysis and electrodeionization. Modern techniques used with development of whey processing methods during recent 15 years have focused on quality and

security in maximum level and methods of sophisticated separation and separation into fractions. Chromatographic methods lead in commercial scale whey protein isolation and separation into fractions. Additionally, developments in membrane process enable wider scaled production of special whey ingredients (high-amount protein / peptide isolates and fractional /purified bioactive proteins etc.). Lactose in great volumes and permeate rich in mineral release during whey processing. Modern technologies have led up also commercial scale simple and effective lactose hydrolysis and isolation supporting development of low-cost production in recent 10 years. Whey industry develops new and modern applications for whey and whey ingredients in order to increase range of healthy food products. Whey and whey products have a wide range of use in many fields primarily; agriculture, food and biotechnology for different purposes.

2.7. Whey: From Effluent to Valuable Products

Whey leads to considerable environmental problems due to the fact that it releases in high volumes and contains high organic matter. It is required to develop cost-effective use of whey in order to produce valuable products and prevent harmful effects that can occur in environment at the same time. In this sense, it is obvious that use and utilization of whey in great amounts provide dual benefit. Production of dairy industry ingredients and obtainment of whey are shown on Figure 2.6. Some of basic by-products such as lactose produced using whey are also shown on Figure 2.4. Dairy products produced from whey in dairy industry are used as ingredients in products such as yoghurt and ice-cream. Whey and materials included in its compound are used also as value-adding ingredient in many

food products such baby foods, bakery products, meat and fishery products. Additionally, whey has many applications in nutrition. Nowadays, there has been an increasing attention and interest on whey as a functional food within its positive effects on health. There is also an increasing interest on use of whey and its components as functional ingredient in dietary and health products such as clinical and dietary foods. Bioactive whey components as well as bioactive proteins are used in a gradually increasing way in pharmaceutical industry as well as in nutrition area. Whey products over rate of 25% are used in human nutrition in EU. It is predicted that use of whey and its products in human nutrition will increase in considerable amounts in near future.

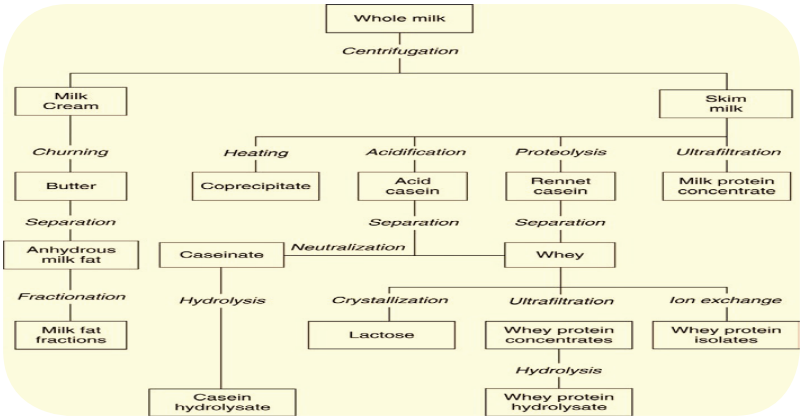

Figure 2.6. Flow diagram for production of dairy ingredients – Recovery processes for whey.

2.8. Factors affecting whey products quality

All steps beginning from quality of raw milk included in cheese production affect quality of whey and its products due to the fact that whey releases when milk is processed into

cheese. In the following stages; periods including storage of whey, getting processed into product and storage of product also affect quality of the product.

Required properties of milk to get processed into cheese;

- Milk must be milked and kept in hygienic conditions,
- Milk must be cooled if not processed just after milking,
- Milk must be pasteurized in order to remove pathogens.

Production must be kept under preservation for purpose of hygiene in order to prevent microorganism contamination during cheese production. Clarification is the leading one of the first pretreatments to be applied during processing of whey into products. Cheese curd parts are removed from whey applying centrifugal force in this process. This process is a significant process affecting taste-flavour and solubility features of final product.

Another significant process applied to whey is pasteurization and it is a required process to be performed for product is to be stable in microbial aspect. Whey must be cooled below 5ºC as soon as possible if it is obliged to get stored before it is processed into product after these steps. It is known that a great part of whey produced all over the world is processed into whey powder. In accordance with Turkish Standards (TS 11860), whey powder must be white or cream coloured, have its own structure, appearance, taste and flavour, and must not have any foreign substance. Humidity rate must be at most in 4.5% rate, total protein amount must be at least in 11% rate and lactose amount must be at least in 65% rate. Microbiological properties of whey powder in same standard have also been given. Types of microorganisms included in product have

importance in determination microbiological quality whey powder. Quality characteristics of whey powder are affected by processes applied during production considerably.

Whey powder may not be accepted as a safe product in microbiological aspect because of three reasons determined in the following;

- Microorganisms included in whey may not be inactive within applied heat treatment,
- Some microorganisms may have developed during various process steps applied while being processed into whey powder,
- Microorganism contaminations may arise during production.

A significant quality criterion is solubility level of product for powder products including also whey powder. Powder products are required to get dissolved in water easily. The most significant factor effective for product solubility to be high is applied drying process method. It is known that solubility of whey powder produced using "spray drying" method is in high level. It has been indicated that solubility rate of A class whey powder is 98% and solubility rate of B class whey powder is 85% in accordance with TS 11860. It has been detected that whey powder forms aggregates and then it transforms into a solid mass (cake) in such a way that its quality is affected negatively in the event that whey powder absorbs water in air. Lactose crystals are responsible for this situation. Cake does not form in values of low water activity (below 0.4) since water is required for lactose crystallization. For this reason, it is the most significant process affecting product quality to pack whey powder in such a way to break its relation with humidity in air. Whey powders must be packed in such a way not to

pass air, humidity and light in accordance with TS 11860. One or a few folded plastic containers, laminated, plastic or wax, aluminium or polyethylene coated paper bags, tin cans can be used in packaging in accordance with legislation (TS 1234). Whey powders can be packed in vacuum or non-vacuum way or packaging process can be made using inert gas (nitrogen in 80% and CO_2 in 20%). Whey powders cannot be stored and transported in smelly locations that can spoil its feature. Packages containing product must be cuttled on dry ground and wooden grid in such a way that it can take air in a good way. Whey powder must be kept from sun light during storage and transportation, and measures must be taken to prevent spoiling.

3. WHEY PROCESSING: Utilization and Major Products

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3.1. Utilization of whey *in food industry*

Whey has a very wide area of use in food industry. Various alcoholic and non-alcoholic beverages are produced using whey although it is not known widely in our country. Whey proteins are used in production of sugary products as cake and chocolate, in sweets and many types of dessert due to the fact that they provide structure and humidity control, increase properties of producing emulsion and foam. Whey proteins are used in production of products such as cream, mayonnaise, spreadable cream cheese, meat and salad sauces due to the fact that their emulsion capacity and stability are in high levels. Additionally, whey proteins are used as thickener, which have property of high-level gelling in cream-soups, meat sauces and similar products.

Whey concentrates are used to develop structure in Quark, Cottage and processed cheese, increase yield in Cheddar cheese and obtain more viscous product in yoghurt making due to water binding property. Whey proteins have area of use in also meat industry due to properties of water binding capacity, stable emulsion formation and fat binding. Whey powder is used in meat products such as sausage and salami and in some sauces. Besides; whey powder, instead of skimmed milk powder, is used in bakery products such as cake, biscuits and pastry due to the fact that it contains lactose in high amount. Whey proteins are utilized from in also production of baby foods. It has been given place to data related to use of whey in food industry in following chapters in more details.

In the Field of Medicine:

It has been indicated in conducted numerous clinical trials that whey has given successful results in treatment of **Cancer, HIV, Hepatitis B, cardiovascular diseases and osteoporososis.** Researchers have conducted trials on mice such as biological and physiological changes, measurement of muscle glycogen level and changes in performance due to whey protein based food consumption before they analyze effect of whey proteins and amino acids on human health. Then, they have determined their effects on various diseases on human. It is introduced that whey proteins have more effects on cancer compared with casein. Studies and researches carried out on animals indicate that whey prevents tumourigenesis and cancer risk decreases as a result of this situation. It has been determined on a trial carried out on mice that whey proteins are effective in preventing colon cancer compared with other proteins such as meat or soybean proteins. It has been reported

that diets supported within lactoferrin or β-lactoglobuhn increase protective effect against development of tumour premises on intestinal wall. Glutation is the essential material of antioxidant and immune systems of body. Whey proteins are unique proteins increasing glutation production due to the fact that cystein concentration is in high level. There are studies and researches related to the fact that lactoferrin and lactoferricin in whey also have antioxidant property. It is also reported that whey protein based bioactive peptides perform protective effect against hypertension inhibiting angiotensin converting enzyme (ACE). Some findings are included related to the fact that whey prevents osteoporosis formation due to lactoferrin and lactoperoxidase supporting bone development and protection and also obesity formation protecting body structure within weight control. It is reported that lactoferrin consumed within foods is effective against pathogens such as bacteria and virus. For example, it has been indicated that lactoferrin is protective against *Haemophilus influenza* virus leading to otitis in children. It has also been discovered that lactoferrin has protective effect against various viruses containing cytomegalovirus (CMV), influenza type A and B, rotavirus, Herpes simplex type 1 and 2 and hepatitis C. Additionally, it has been detected that plasma glutation concentration increases in considerable levels in HIV patients consuming whey supplements. Researches and studies are also included related to the fact that whey proteins reduce cholesterol levels of plasma and liver.

Nowadays, whey proteins and amino acid supplements are in superior position compared with medical drugs generating side effects on humans. For this reason, more physiological applications should be carried out and results should be defined

after effects of whey proteins and bioactive components are detected.

In agriculture and livestock breeding:

Whey is a by-product having potential of use in some agricultural activities and animal nutrition. Some conducted researches have indicated that whey has inhibitor effect against some plant viruses. Researchers have demonstrated the fact that spraying whey on surfaces of barleys has prevented any type of virus from passing through plant surface and virus from spreading on field. They have discovered that this antiviral effect is related to whey proteins. It has been detected in another conducted research the fact that whey is sprayed on tomato leaves during 6 days has reduced activity of tomato mosaic virus prominently. It has also been indicated that whey is effective against some types of viruses that can develop on cucumber and tobacco. Samples are included in agricultural activities related to the fact that whey is used as insecticide. There are some researches and studies on use of whey for control of thysanoptera eating saplings.

It is reported that whey has potential of use as bait for thysanoptera on citrus fruits. Whey is combined with phloxine B; photoactive paint for control of this insect commercially. There are some researches and studies related to use of whey in also control of insects on flower bulbs. Whey can be used in such a way that it can be made animals drink directly or added into feeds. It has been detected in researches and studies carried out mostly on ruminants that digestibility of dry matter components in feed increases in the event that fodder is given animals softened by whey rather than water. It is also specified that rate of utilization from protein and phosphor increases if whey is added into feed in 5% rate.

In sports nutrition:

Whey proteins are used as ingredient in sports drinks due to the fact that they include high-quality protein. Conducted researches indicate that whey proteins are to provide numerous benefits with athletes. Some clinical trials have indicated that whey proteins taking place in diets of athletes increase athletic performance directly. Especially WPC 80 and WPI (look at Chapter 3.2 for detailed information), within fat and lactose ingredients in minimum level, provide high-quality protein for athletes.

Amino acid profile of whey is similar to amino acids in skeletal muscles to a great extent. Whey protein supplements generally contain basic amino acids in more rates than other protein sources. These basic amino acids are the amino acids required for protein synthesis in muscle. Whey protein supplements are rich in also branched-structure amino acids. These amino acids are leucine, isoleucine and valine. These amino acids have significant role in muscle metabolism for athletes. Due to the fact that these branched-structure amino acids, especially leucine have key role in DNA translation in protein synthesis, it leads to a more effective recovery that these muscles are provided this amino acid after training. Cystein amino acid in structure of whey proteins assists athletes to keep their body weight as well as muscle development.

Whey proteins have unique value by the fact that they are digested more differently than other proteins. The fact that they are absorbed rapidly in body leads more amino acids to reach tissues and leads protein synthesis in higher rates resulting within higher protein gain. It enables whey proteins to get consumed before, during and after training that whey proteins are easy to dissolve in water and can be mixed with any

liquid easily. Whey proteins are one of several recommended nutritional supplements in order to develop physiological adaptation and increase athletic performance during exercise. Researches are not in adequate level yet, which are made upon use of whey proteins to optimize athlete health and performance. For this reason, more clinical researches should be completed in order to make more clear recommendations.

In cosmetics Industry:

Nowadays, technological developments in cosmetics industry are shaped within the framework of quality of products, use of natural resources in production and environmental concerns. Hydrocolloids as well as proteins in cosmetics industry are used in production of products having functional properties and biological activity.Whey is a significant resource taking place in natural cosmetic ingredients due to valuable compounds, primarily proteins, it contains. Properties of whey proteins; water binding, foam formation, emulgator and gelling come into prominence related to this matter. Hydrolyzed whey proteins take place among functional ingredients defined as safe in cosmetics. Hydrolyzed whey proteins have potential of use as skin moisturizer in cosmetics, which are obtained as a result of partial hydrolysis of whey proteins by acid, enzyme or other methods.

It has been determined that low-molecular-weighed compounds included in whey proteins have very similar features as natural moisturizer factors in human skin. Low-molecular-weighed fraction of whey minerals appropriate for cosmetics releases as a by-product during production of whey concentrate or isolate from whey. The capabilities of these materials such as solubility in water, water binding and rapid

spreading in cells show similarities as hyalunoric acid used in cosmetics industry. For this reason, these materials obtained from whey are used in cosmetic products and soaps, lotions produced for babies. It has also been indicated within clinical trials that these cosmetic products are also good for dermatitis; a skin disease.

Results of a research carried on use of whey in shampoos have indicated that whey can be used successfully in this product. It has been determined in the same trial that use of whey in shampoo makes a positive effect on foaming capability. Surface active agents such as alkyl ether sulphates are detergents used primarily in shampoo formulations. Although foaming and washing features of these materials are very good, they may lead to oil loss in hair too much and irritate eye and skin. It has been thought that use of a natural product such as whey in shampoos can overcome this problem. Whey proteins and minerals also function as an effective thickener for shampoo and increase viscosity of product. Use of whey, as a cosmetic ingredient, is a matter requiring more intense and detailed study and research on due to the fact that use of whey becomes another application in waste utilization and provides use of a natural raw material in cosmetic products in this way.

In energy production:

Utilization of food industry wastes through degradation in oxygen-free (anaerobic) environment provides a significant opportunity for renewable energy. Anaerobic degradation is a technology applied for not only wastewater treatment process but also production of heat energy and electrical power. Whey is characterized within its organic matter ingredient in high level and low buffer capacity. For this reason, the fact that

whey is applied direct anaerobic process results in a rapid acidity development and low biogas production. Therefore, whey is known to become more effective in energy production in the event that it is mixed with other types of wastes and/or fertilizer. Several studies and researches are included, which are made upon this matter. Biogas production has been performed in one of them using whey and cattle droppings as a result of anaerobic degradation. In another study, hydrogen and methane gas production has been performed using mixture of pre-processed storehouse millet (55%), whey (40%) and liquid cow manure (5%) and a two steps – anaerobic process. Additionally, biohydrogen has been produced mixing whey with wastes of fruit-vegetable industry in another trial.

3.2. Major Products: *Whey Powder*

One third of whey produced all over the world is processed into whey powder. In accordance with TS 11860; sweet whey powder is defined as the product obtained by the fact that remaining liquid compound of which changes due to types of cheese and making technique after casein and fat are separated as curd during cheese making by use of rennet. In accordance with TS 11860; sour (acidic) whey powder is the product obtained by pulverizing liquid obtained filtering from precipitation, in accordance with technology, as a result of the fact that milk is precipitated by acid.

Photo 3.1. Whey powder

Whey powder products are used in quite various areas in food industry; the most widely in order to aromatize foods. This property of whey powder is utilized in primarily nuts coatings (for example; popcorn, nacho, tortilla); pressed nuts, cheese based sauces, potato chips, salty flavours and salty biscuits. Use of whey powder provides production convenience in special bakery products such as pizza, biscuit and macaroni and in souffle and cake making. Foods produced within addition of whey powder can have same structure, taste-flavour and appearance as foods containing cheese. Whey powder is preferred to get used more rather than milk powder in biscuit sector because of economical reasons and preservation convenience.

Figure 3.1. Flow diagram for production of whey powder

Pretreatments

• ***Clarification:*** Curd particles in whey are removed using clarificators running in accordance with principle of separation by centrifugal force. Otherwise, curd particles are to lead to obstructions in polymeric UF membranes and plate heat exchangers. They are also to affect taste-flavour and solubility properties of final product negatively.

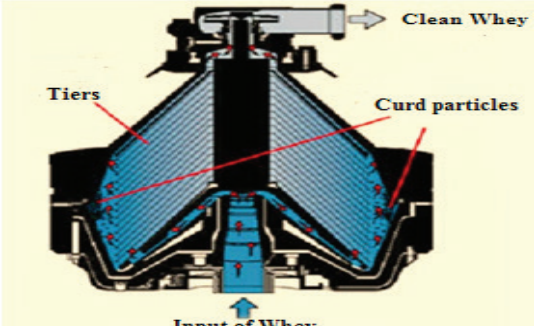

Figure 3.2. Clarificator

• ***Cream Separation:*** Fat transition (leakage) into whey is inevitable during cheese production; except fat-free cheese. It is obligatory to make whey skimmed both for taste-flavour stability of product and economically. Fat remaining after separation is in almost 0.06% rate.

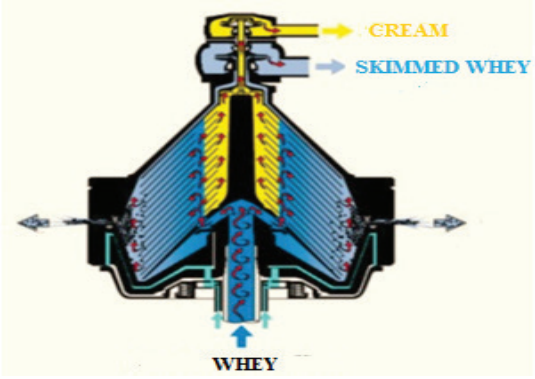

Figure 3.3. Cream separator

• ***Pasteurization*:** Whey needs to get pasteurized just after obtainment in order to optimize its microbial quality. If whey is obliged to get stored just before heat treatment, it must get cooled below 5°C as soon as possible.

Concentration of whey

• Dry matter conteny of whey reach a level of 40-60% by application of evaporation process.

Final Treatment

• ***Crystallization and drying process of whey*:** The last stage for processing of whey into powder is dehydration (removal of water) of concentrated whey by use of spray driers. Powder products obtained by use of these types of driers have solubility in high rates. Whey powder is obtained as a result of this

dehydration process. However; in the event that concentrated whey is dried directly, obtained powder is to be extremely hygroscopic (desicant) and this situation is to lead to tendency of aggregation during storage and even in drier. A great part of hygroscopic β-lactose form of lactose needs to get crystallized into form of non-hygroscopic α-lactose in order to prevent it. A controlled crystallization is performed by the fact that its concentrate is to get cooled up to 30ºC rapidly and then micro-scale lactose is to get formed.

Whey Protein Concentrates

Whey protein concentrate (WPC) is defined by American Food and Drug Administration (FDA) as the product obtained by removal of materials not containing protein sufficiently and containing protein in at least 25% rate in final product. WPC is produced by use of physical separation techniques such as precipitation, filtration and dialysis. WPC can be used in form of liquid, concentrated and powder product. A great part of WPC in market contains protein in either 34-35% rate or almost 80% rate. WPC containing protein in almost 35% rate is used in yoghurt, processed cheese and baby foods, and in some bakery products. WPC is preferred to get used in also meat products such as sausage due to binding property as well as nutritional supplement. On the other hand, lactose and mineral matter ingredients in high rates are prevented in WPC products containing protein in 80% rate. Performance of WPC containing protein almost in 35% rate in food applications is based on combined effects of protein, lactose and minerals in these products.

Some specific whey protein products such as extruded WPC containing protein in 50% rate are generally used in meat industry and production of protein bars. WPC containing

protein in 80% rate has been designed for applications containing proteins having dominant functional role. These products are commonly used in applications such as gelling, emulsion and foam formation. It makes this product an ideal ingredient for sportsman nutrition and products providing weight control that these WPCs contain carbohydrate in low levels. Another application area for these types of ingredients is meat products, and they provide gel firmness and water-binding capacity in high levels for product.

Ultrafiltration (UF)*:* UF is a filtration process run under pressure, containing membranes and used in separation components in any solid-liquid mixture for size and shape. Membranes used in ultrafiltration of whey do not enable proteins (macro-molecules) to pass through; on the other hand, they enable water-soluble micro-molecules such as lactose and minerals to pass through. WPC in powder protein ingredient of which varies between 35% and 85% can be produced by use of UF.

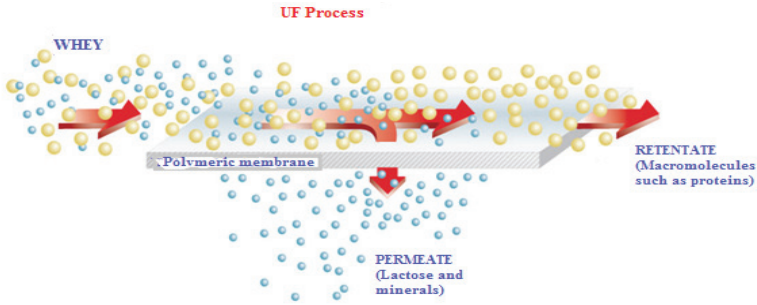

Figure 3.4. Ultrafiltration (UF).

The term; **permeate** defines the part passing through membrane when whey is pumped into UF system. **Retentate**

also defines the part separating from system without passing through membrane.

Whey Permeate: Whey proteins are held by membrane during ultrafiltration and diafiltration; compounds such as lactose and minerals having lower molecular weight form permeate passing through filter. Remaining and gathered materials after protein moves away are called as "whey permeate" or "deproteinized whey". Remaining lactose solution is crystallized and thus lactose production is performed as soon as minerals in this part are demineralised. Compound of whey permeate varies in accordance with type of milk, cheese and processing conditions; however, its basic component is lactose. Typical compound of this permeate forms in such a way; lactose in 65-85%, protein in 3-8%, ash in 8-20%, fat in< 1,5 % and humidity in 3-5% rates. Whey permeate can be used in order to develop browning characteristics in various processed foods and bakery applications, in final product and during shelf-life.

***Demineralization (Removal of Minerals)*:** "Ion exchange" or "electrodialysis" methods are commonly used in order to perform the demineralization. Demineralization of deproteinized (by UF) whey is obligatory as pretreatment. This process is performed also in production of reduced mineral and demineralized whey. Demineralized whey is commonly used in baby food formulations.

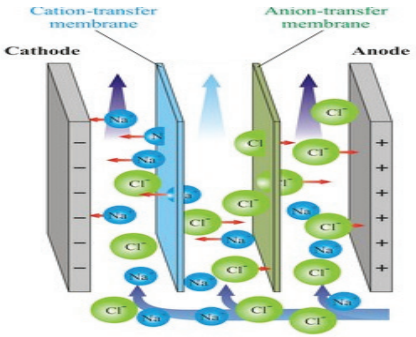

Figure 3.5. Electrodialysis apparatus

Demineralization Techniques

Ion exchange: Ion exchange resins are used in this system. A resin containing charged groups performing this ion exchange is fixed on inner surface of column. Minerals in whey passing through this column are held by resin.

Electrodialysis: It is the process to transfer ionic compounds in a solution by effect of electrical power. The fact that ions are transferred in accordance with their charges is performed by an ion-permeable membrane.

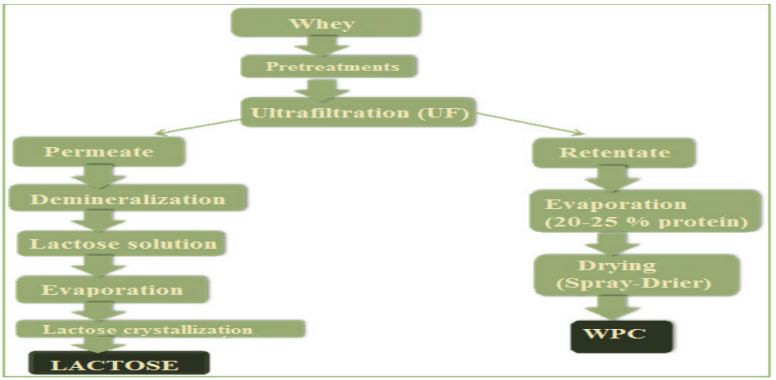

Figure 3.6. Flow diagram for WPC and lactose production

Table 3.1. Proximate compound for whey and protein products produced from whey before concentration and drying processes (%) (Harper, 2011).

	Protein	Lactose	Fat	Minerals	Water
Whey	0.9	4.8	0.05	0.5	93.0
WPC-35	3.3	4.8	0.2	0.7	91.0
WPC-60	11.5	5.2	1.0	0.8	71.5
WPC-80	20.0	1.0	2.0	1.0	76.0
WPI	19.0	0.2	0.2	0.6	80.0

Whey protein isolates

Another one of basic protein products produced from whey is whey protein isolate (WPI). WPIs contain protein in and above 90% rate and water in 4-6% rate. Fat, lactose and ash are included in the remaining part of 4-6% rate. Due to high protein purity and solution clarity, WPI is intensively used in nutrition as supplementary, in sports drinks and beverages enriched in protein. Ion exchange chromatography is one of methods used in WPI production. Due protein ingredient in high level, WPI can be used as water-binding, gelling, emulsion and foam formation agents.

Table 3.2. Average compounds for some WPC and WPI products (%) (Foegeding and Luck, 2011

Ingredient	Protein	Humidity	Lactose	Fat	Ash
WPC 35	35.3	3.7	52.3	3.3	5.8
WPC 80	78.7	4.3	4.9	6.4	4.0
WPI	90.9	4.8	1.5	0.9	2.7

Whey protein hydrolysates:

One of methods to get applied to change nutritional and functional properties of whey proteins is enzymatic

hydrolysis. Peptides are absorbed more rapidly and partially in a better way compared with amino acids and proteins. Whey protein hydrolyzates having better nutritional quality and less allergenicity are used in performance improver products and baby food formulations.

Lactose:

Lactose obtained by thickening and crystallization of remaining liquid just after deproteinization, demineralization and removal of fats from whey (Figure 3.6) is used in preparation of specific diets and production of baby food, drug industry, penicillin production, production of caramel colouring, preparation of hydrolyzed lactose syrups and production of lactic acid. It has been detected that Biological Oxygen Demand (BOD) value reduces in 87% rate as a result of the fact that lactose is recovered from whey in sufficient amount. Lactose is basic component of whey dry matter and it transforms whey into a potential raw material in production of various biopolymers. In this sense, it makes it possible to produce new products from whey that lactose is degraded by microorganisms. These products can be ranged as organic acids such as ethyl alcohol, kephir-like fermented whey beverages, lactic acid and citric acid; biopolymers such as bread yeast, single cell protein, probiotic starter cultures, biogas, bioplastic, and ethyl lactate.

Glucose and galactose generation is also performed by lactose hydrolysis. It is an important advantage that calorie and glycemic index of lactose are low compared with other carbohydrates. UF membrane is used to separate proteins, increase reverse osmosis lactose concentration in lactose production. Evaporation method in production, in order to

dewater in structure, crystallization method in next step and spray drying method in drying stage are applied. The most common lactose type used in industry is α-lactose monohydrate. Compounds such as lactulose, lactitol and lactobionic acid are not absorbed in small intestine, which are produced from lactose or whey. For this reason, these compounds have potential power due to the fact that they function prebiotically within incentive functions for development of useful bacteria in large intestine. Additionally; lactitol, as it is a sugar alcohol, is a sweetener that can replace with sucrose and be used in diabetic products.

Lactalbumin:

At first, pH value of whey is fixed in 4.5-5.2 in lactalbumin production within traditional method. Then, heat treatment is applied for denaturation of serum proteins and almost 80% rate of proteins is precipitated. Solubility of product obtained in this way is in low level; but its nutritional value and water-binding capacity are in high levels. Thus, it is used in bakery products, meat products, processed cheese and sweets. pH value of whey in production of lactalbumin within permanent method is fixed in 6.0. Whey is heated up to 120^{o}C by steam injection for denaturation of serum proteins and in order to provide it to separate. Lactalbumin produced in this way contains ash in 20-25% rate. pH value of heated whey is fixed in 4.6 in order to reduce ash ingredient into 2-5% rate. It is used in macaroni or similar bakery products as solubility level of product produced in this way is low. Production of lactalbumin having high level solubility above pH 5 is performed in another permanent method used in lactalbumine production. pH value of whey is fixed in 2.5-3.5 in this method and heat treatment is

applied in 90°C. pH value is fixed in 4.5 in order to precipitate denatured serum proteins after cooling process. A product protein ingredient of which is in 40% rate is obtained in this way.

Demineralized and Reduced Minerals Whey:

Almost 10% rate of whey dry matter consists of mineral matters. It is thought that it is not appropriate for animal nutrition and its rate is too high for baby foods within this high-level mineral ingredient. For this reason, demineralised whey products (demineralised in 30-90% rate) have increasing importance. "Ion exchange" and "electrodialysis" methods are commonly used for demineralization (removal of minerals). This process is performed in production of reduced minerals and demineralized whey. Demineralized whey is commonly used in baby food formulations. "Ion exchange" and "electrodialysis" are the most commonly used methods in demineralization techniques;

Ion Exchange: Ion exchange resins are used in this system. A resin containing charged groups performing this ion exchange is fixed on inner surface of column. Minerals in whey passing through this column are held by resin.

Electrodialysis*:* It is the process to transfer ionic compounds in a solution by effect of electrical power. The fact that ions are transferred in accordance with their charges is performed by an ion-permeable membrane. In this way, anions included in whey move towards cathode and cations move towards anode, thus demineralization occurs. (Look at Figure 3.5).

Reduced lactose whey:

Lactose intolerance is a disorder arising from birth, or absence or lack of lactase (ß-galactosidase) enzyme as a result of any infection or insufficient nutrition. Whey is obliged to be delactosed or lactose rate is obliged to be reduced as well as milk in production of dairy products for individuals having this disorder. Reduced lactose whey and whey products can be produced by application of filtration methods to whey such as ultrafiltration (UF). Another method used in removal of lactose from whey includes steps of partial crystallization of lactose from whey and then recovery of lactose by centrifugal separation. Lactose is included in powder products obtained by this method in 60% or less rate. Chromatographic methods are also developed for removal of lactose from whey. Reduced lactose or delactozed whey products do not have a sweet taste unlike lactose hydrolyzed whey products.

Lactose hydrolyzed whey powder:

Lactose is hydrolyzed into glucose and galactose by an enzymatic method in these products. ß-galactosidase enzyme is used for lactose hydrolysis in whey. Sweetness rate of hydrolyzed lactose (glucose and galactose mixture) is almost in 70% rate of sucrose known as tea sugar. For this reason, lactose-hydrolyzed whey products are appropriate for sweet dairy products such as fruit yoghurt and ice-cream, and whey beverages.

Protein hydrolyzed whey powder:

It is one of methods to get applied in order to change nutritional and functional properties of proteins in whey to hydrolyze them by enzymatic methods. Peptides and amino

acids release by hydrolysis of proteins. Peptides and amino acids are absorbed more rapidly and in a better way partially compared with proteins. Protein hydrolyzed whey products having better nutritional quality and less allergenicity are used in performance improver products and baby food formulations.

Dairy mineral products:

Milk is a kind of food containing remarkable minerals such as calcium, magnesium and phosphate in sufficient levels. Mineral matters included in water soluble components pass into whey.

There is a gradually increasing attention on foods enriched within minerals as well as vitamins. Dairy mineral products rich in calcium and phosphate based on natural milk are very valuable food supplements particularly nowadays when disorders such as osteoporosis are common. These products are produced by precipitation and separation of calcium phosphate from whey permeate in proper conditions of concentration, pH, temperature and duration. Centrifuge and filtration processes are applied just after precipitation process. Dairy minerals are used as natural calcium supplement increasingly in products such as drinking milks, yoghurt, milk powder and sweets products.

Whey cheeses:

There are two types whey cheese (Ricotta-type whey cheese and Mysost cheese) defined by International Dairy Federation (IDF). Basic difference between these two types of cheese is production techniques (Figure 3.7). Italian-type whey cheese is Ricotta cheese and similar products are produced also in Turkey (curd cheese), Portugal and other regions. Production of

these products is based on heat treatment and acid coagulation of proteins. Curd cheese consumed commonly in our country is obtained by boiling whey, precipitation and filtration of proteins. Ricotta cheese is a type of cheese produced by precipitation of proteins adding sour whey just after whey is heated at 90ºC and resembles curd cheese. Mysost cheese contains all components of whey differently from these types of cheese and water vapour releases solely during production. Mysost cheese is obtained as a result of heating and thickening whey and a controlled lactose crystallization. The part curdled by heat treatment application in production of Curd and Ricotta cheese types is proteins; α-lactalbumine and β-lactoglobulin that do not react with rennin, and pass into whey. It is sufficient to apply heat treatment to whey proteins at 77.5°C for 1 hour, at 80°C for 30 minutes and at 90°C for 5 minutes so that whey proteins can be denaturated completely.

Adjustment of acidity rate can be made by addition of phosphoric acid, tartaric acid, lactic acid, citric acid or acetic acid as soon as the first curd particles are observed in making process of curd cheese from whey remaining from cheese made of cow's milk. Sour whey powder and ultrafiltered sour whey can also be used in dairy plants for this purpose. These changes in pH affect denaturation of α-lactalbumine and β-lactoglobulin at 78-100°C and combination of denaturated proteins, and this situation also affects yield and quality of curd cheese. pH value of whey obtained from cheese types made of cow's milk must be between 4.5 and 5.2. However, acidity is not adjusted in whey obtained from ewe's milk. Other materials used in curd making are $CaCI_2$ and NaCl supplements that are used to improve cheese taste. NaCI is used at 70-75°C and in 0,1-1,5% rate. It is the reason to use NaCl that it increases denaturation

degrees of whey proteins. Precipitated part at the end of heat treatment is put on press cloths after it cools to a degree and left on infiltration. Curd cheese is not salted if it is aimed to get submitted for consumption as fresh. The product is obliged to get salted if it is stored.

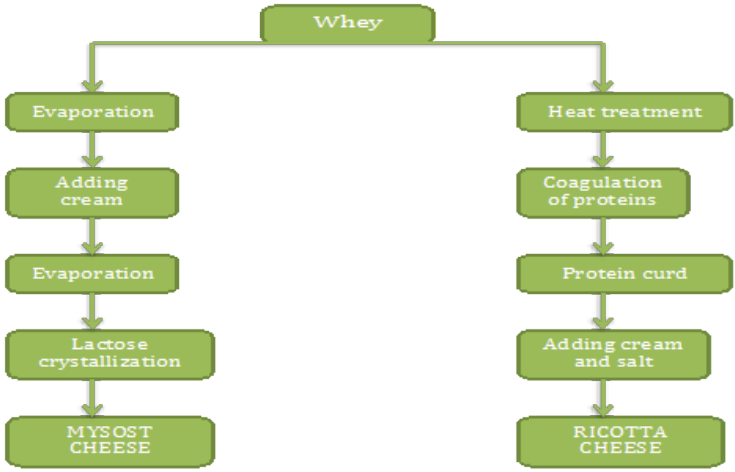

Figure 3.7. Flow diagrams for production of whey cheeses.

***Whey beverages**:*

Beverage production from whey has started in 1970s. One of the earliest whey beverages is *Rivella* produced in Switzerland. Production of different, natural sweet or sour, deproteinized, diluted, fermented and dried types of whey has been developed widely up to now. Whey based beverages target a wide consumer group from old people to kids. They have been used in treatment of some diseases such as tuberculosis, disorders in skin and digestion system since Ancient Greece Age. In 18th century, specialized institutions have been found

and detailed researches have been made on nutritional and therapeutical features of whey for treatment of diseases with whey. Whey has been applied successfully in treatment of diarrhoea, bile diseases, skin disorders and problems, peelings in urinary area and some intoxications. These beverages are also ideal nutrition and energy sources for athletes due to the fact that they include high nutritional value and characteristics, and proteins in high amounts.

Whey proteins include also lactoferrin, which is an iron binding protein, glycomacropeptyde (GMP) releasing after usage of rennet in cheese-making, naturally free phenylalanine and α-lactalbumine, which is a calcium binding protein. Due to existence of lactoferrin, as functional food; whey can be benefited from in order to develop iron absorption from required foods and/or prevent from getting connected to intestinal walls holding pathogens. These beverages are significant in also nutrition of old people who especially have osteoporosis disorder since they increase calcium absorption.

Photo 3.2. Beverages produced from whey

Non-Alcoholic whey beverages:

Production of whey beverages formulas and methods of which have been developed during the last ten years has been registered with patents in such a manner that fruit concentrates are added into and amounts of fruit dry matter are between 5-20%. Among these beverages; citrus-flavoured beverages and beverages into which other tropical fruit flavours such as mango, banana or papaya are added are frequently recommended. Because, it has been indicated that these beverages are very effective in masking undesirable flavour of baked milk and salty-sour flavour of whey. Besides that, studies and researches have been made upon also usage of concentrates of fruits such as apple, pear, peach, apricot and cherry. Successful results have been obtained from trials to add fruits such as mulberry, a good source for iron and antioxidants, into these products. Apart from fruits, some researchers have also applied the usage of other flavour agents such as chocolate, coca, vanilla, cereal (mostly; rice, oat and barley) and honey. It is regarded as very interesting to add cereals; especially bran. It has also been performed to produce beverages enriched within dietary fibre, basic fatty acids (addition of oat).

It has been known for a long time that probiotic whey beverages produced as a result of fermentation of whey with various lactic acid bacteria have demonstrated positive effects upon human health such as to decrease cholesterol level in blood, regulate lactose metabolism, decrease blood pressure, develop anti-carcinogenic features and immune system. Dietetic beverages also take place in category of non-alcoholic whey beverages such as hydrolyzed lactose beverages, milk and powdered beverages do. Due to its compound and

properties related to its compound, whey is a good raw material for production of simple dietetic beverages into which some types of sweetener agents (mostly; saccharine and cyclamate), apple or some types of tropic fruits and stabilized agents are added. These beverages have very low energy value (104-103 kJ/100 mL) and this property makes them appropriate to get consumed by a wide range of consumers. Milky beverages are also produced by mixture of liquid or powdered whey with skimmed milk or whole milk, buttermilk, some types of vegetable oils, hydrocolloid and emulgators. Milk is added in order to develop concentration and stability of beverage. *Way-Mil*, one of the most well-known products in this category, is milky, has its own flavour and may include supplements such as chocolate and fruits. The product contains approximately; milk fat in 2-4% amount, protein in 1-1.5% amount, lactose in 4-5% amount, mineral in 0.7% amount and water soluble vitamins. These products may also get enriched within vitamins and minerals. Compared with liquid beverages, these products can be transported and stored more easily; so, they are remarkable in society nutrition in circumstances that protein sources are limited and living conditions are hard. Production of whey powder beverages generally includes mixture of whey with soybean, fruit powder, concentrated fruit juice or whey protein concentrates.

Alcoholic whey beverages:

Whey is a very good raw material for production of alcoholic beverages due to the fact that lactose is main component of whey dry matter (approximately, 70%). Alcoholic whey beverages called as low alcoholic (≤1.5%) beverages are produced through stages such as; direct fermentation of

lactose (generally with yeast types such as *Kluyveromyces fragilis* and *Saccharomyces lactis*) or sucrose addition up to desired alcohol level (0.5-1.0%), aromatization, sweetening and packaging. Thus, current lactose amount transforms into lactic acid, remaining ferments both transform into alcohol and provide a sour flavour in this final product. "Milone" obtained by fermentation of whey with kephir culture and whey sparkling wine produced in Poland and known as "Serwoit" are in this category.

Whey beer can be produced as malt-added or not added. This product can get enriched by minerals or contain starch hydrolysates and vitamins. Whey wine has low alcohol amount (10-11%) relatively and it is generally provided flavour-smell within fruit flavours. Production of whey wine includes stages; clarification, deproteinization, hydrolysis of β-galactosidase and lactose, transfer and cooling after decantation, addition of yeasts and fermentation, transfer, ripening, filtration and bottling. Furthermore; sucrose and caramelized sugar, beer yeast, fruit flavour and water is added into deproteinized acid whey, the mixture is bottled, left in fermentation for 8-12 hours in 18^{o}C and thus whey champaigne is produced finally. It has been studied on production of functional whey beverage using WPC (containing protein in 35% rate) and some of selected lactic acid bacteria in a conducted research. It has been demonstrated that a type of beverage whose level of β-lactoglobulin, basic milk allergen, is low and rate of branched basic amino acid is high can be produced within fermentation of WPC.

4. INNOVATIVE PRODUCTS PRODUCED FROM WHEY

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4.1. Lactic Acid

Undesired microorganisms are removed by applying heat treatment to whey and homofermentative lactic acid bacteria are inoculated, thus; lactic acid is obtained. Lactic acid bacteria; *Lactobacillus, Lactococcus, Streptecoccus, Leuconostoc* and *Pediococcus* are the species used widely in production of lactic acid. Lactic acid is used in food, drug, leather and textile industries. It has applications primarily as "preservative" and "acidifier". There has been an increasing interest in lactic acid production in recent years, because; it has been used as raw material for production of polylactic acids. Polylactic acids are a type of polymer used in production of specific drugs and environment friendly biodegradable bio-plastics. It is the leading one of the most important matters to design proper bioreactors to get used in order to perform lactic acid production successfully. It is considered that innovative usage of whey, within the latest biotechnological techniques and bioreactor designs, continues to take place in the matters drawing intensive attention for the sake of efforts to solve basic environmental pollution problem that milk industry encounters.

4.2. Ethyl alcohol

First studies and researches on ethanol production through whey fermentation are based on 1940s. It has been achieved to decrease environment pollution and transform lactose into ethanol synchronously and it is used widely nowadays. As a result, processing of whey and synchronous ethanol production is a subject drawing great attention. It is reported in various studies and researches made on this subject that whey, whey powder solution, whey permeate obtained from UF and even deproteinized whey are used in accordance with this purpose. This operation is performed using a specific group of microorganisms. Maximum 0,538 kg ethanol is released per 1 kg lactose theoretically in reaction which biotransformation of lactose into ethanol is conducted. However, transformation of lactose in whey or whey permeate into liquid ethanol is an application hard to compete with economically in comparison with other raw materials such as corn starch or cane sugar. Ethanol obtained from whey can be utilized in food, chemical, drug and cosmetic industries and also as an alternative and sustainable fuel.

4.3. Single cell protein (SCP)

Hazardous increase in world population leads to increase in demand in food production, particularly in third world. This situation causes demand on innovative and alternative food sources. Production of single cell protein (SCP) is one of basic steps in this aspect. SCP is defined as protein extracted from cultivated microbial biomass. SCP can be utilized in order to supplement protein as alternative for costly conventional sources such as soy meat and fish meat. Furthermore, biological transformation of agricultural and industrial wastes into foods rich in protein provides advantage in obtainment

of final product within lower costs. Since, lactose in cheese whey is the major contributor to BOD, using the whey as a substrate for the production of single-cell protein (SCP) also reduces its pollution potential while results in the production of a value added product. Production of microbial biomass from whey has been performed commercially since 1940s. SCP production from whey within industrial scale, for the usage of food, has started in France in 1958. Three different types of mould are used in whey permeate during production. Moulds are enabled to get developed in pH=3.5 and 38ºC for a period of more than one year in continuous system in this plant in France. High temperature and low pH are recommended in order to reduce contamination risk. Oxygen in high rates is transferred into fermentation tanks in order to prevent ethanol formation. Mould biomass is recovered by centrifugation, applied heat treatment in 85ºC and dried in spray driers. It has been determined that obtained SCP contains protein in 48-52% rate, they contain basic amino acids in which lysine amino acid is in high rate and also B group vitamins. Trade name of this product is "Protibel".

Biomass is utilized in animal nutrition primarily but also in human nutrition. The plant in France produces almost 2500 tons of SCP in a year and this product has been utilized in human nutrition for almost 30 years. 2.5 tons of SCP and 100 kg of amino acids are obtained from 100 tons of whey.

4.4. Biogas

Hydrogen is a kind of gas known to be clean energy, which does not get released with greenhouse gases and acid rains. It can be hydrolyzed and purified easily due to its low solution. This gas has high energy efficiency. Furthermore, hydrogen can be used directly in fuel cells to produce electricity.

For these reasons, there is a gradually increasing attention in production and usage of hydrogen to utilize in different applications. Usage of wastes rich in carbohydrate such as whey is an economically valid option for production of hydrogen gas. Hydrogen production is performed with the fact that whey, diluted whey, whey powder solution and whey permeate are subjected to anaerobic fermentation. 8 moles of hydrogen are formed per 1 mol of lactose during this process theoretically. Furthermore, this biogas mixture also contains methane and carbon dioxide gases. Although the fact that it contains carbohydrate (lactose) in high rate sets whey as an appropriate raw material for biological processes, there are very significant problems in anaerobic process of raw whey (biodegradation in anaerobic environment). Because whey has low alkalinity coming out as a result of lactose degradation and high organic matter load. It is obliged to make dilution process, fermentation reactions and add alkaline in proper rates in order to make whey appropriate for this process.

In this sense, it is a promising strategy that methane formation period is separated from acid formation period in order to develop energy transformation efficiency and product stability. Especially, the first phase of this two-step process can be optimized for biological production of hydrogen gas. In the researches carried out on biogas production from mixture of whey and poultry fertilizer, it has been determined that production can be performed without adding any chemicals into whey within this method. Furthermore, studies and researches related to biogas production based on mixture of whey and cattle fertilizer are also included. Handled with an environmental aspect, it is reported that there is a decrease in COD value in almost 80-90% rate and reduction in sugar

consumption between 86 and 97%. Remaining liquid just after hydrogen production is not given nature directly and it is obliged to get processed.

4.5. Bioplastics

Bioplastics, in particular polyhydroxyalcanoates (PHAs), are widely studied as biodegradable materials for substitution of oilderived polymers. At present, however, they have not had a wide application mainly because of their production costs, which are relatively higher than for traditional plastics. Production costs of this process can get reduced by searching for new cheap substrates (1), new fermentative strategies (2), and new recovery and purification steps (3) or by using microorganisms capable of synthesizing and accumulating PHAs to high concentrations.

It is reported that whey compound is proper for biological process taking place in PHA production. Many studies have been performed upon PHA production from whey within different types of microorganisms.

Photo 4.1. Bioplastics produced from whey.

Film and coating materials produced from biopolymers such as protein, starch and lipids, apart from PHAs, are among the subjects which are studied on commonly due to the fact that they provide environmental gains and sustainability. Among

biopolymers; protein macromolecules are the materials having the highest and greatest variability in terms of chemical compound and properties due to the fact that amino acids in their structures are sequenced within numerous probabilities. Usage of whey proteins consisting of globular proteins is applicable in bioplastic production.

It has been researched to utilize whey proteins as packaging material due to the fact that they have perfect oxygen barrier property and whey is released in large amounts. However, it is obliged to reduce structural fracturability of whey bioplastics in order to benefit from these proteins in packaging and other plastic applications. In accordance with this purpose; natural latex and egg white albumin, two biopolymers used widely, have been mixed with whey proteins and its effects on whey protein bioplastics have been researched. It has been put forward in this research that addition of natural latex and albumin in 10% rate has increased resistance of whey based bioplastics without changing their hardness and fracturability. It is reported that edible film and coating materials produced from whey proteins provide antioxidant characteristic in frozen fishes and also prevent bitterness and moulding in roasted peanuts.

Furthermore, whey proteins and monoglyceride mixed coatings are used to reduce moisture content in cereals and stickiness of dried grapes.

4.6. Starter cultures

Lactose and other nutritional ingredients included in whey are required for microbial development and they also transform whey into a potential raw material for production of various bio-products in biotechnological aspect. It is aimed to use

whey products in development of nature friendly technologies, large-scale production of various chemicals (such as ethyl alcohol) and various other foodstuffs of high nutritional and added value (baker's yeast, protein enriched animal feedstock, whey drinks simulating kefir, and starter cultures for cheese ripening or as probiotic food additives). Starter cultures were produced through propagation of *Kluyveromyces marxianus, Lactobacillus bulgaricus* and the mixed kefir culture in whey. Feasible and low cost preservation methods (such as drying) are required for use at industrial scale lactose conversion processes. A low temperature thermal drying process was examined in order to reduce drying process costs of starter cultures. In this sense, freeze-dried and thermally dried starter cultures can be utilized as starter in cheese ripening.

4.7. Other Bio-products

Various organic acids (acetic, propionic, lactic, citric and gluconic acids) and amino acids (glutamic acid, lysine and threonine) used in foods can be produced from whey using different microorganisms and processes. Production of 2, 3-butanediol, which is a basic material for chemical industry and has usage potential as alternative energy source can be performed following a different fermentation way in whey.

It is researched and studied on glycerol production within yeast fermentation in W, as an alternative to organic synthesizing. Xanthan gum production from whey has also been performed successfully. This polysaccharide has applications in oil drilling and textile sector and also in food industry as thickener, emulgator and stabilizator. Production of calcium magnesium acetate from whey can be performed through anaerobic fermentation process. This material can

be utilized as de-froster or de-icer on roads. Production of fructose-diphosphate and salts is utilized in pharmacy. These compounds are obtained through biotransformation of whey using ***Saccharomyces cerevisiae.***

Volatile aroma compounds are produced using *Kluyveromyces lactis*. Whey is utilized as a potential substrate for production of polygalacturonase and other enzymes as well as plant hormones and these aroma compounds. Biogenic glycine betaine and trehalose are the compounds used widely in many areas such as food and textile industry, medicine, bioprocess industry, agriculture, genetic engineering and animal nutrition. For this reason, industrial production of these products is very significant. Glycine betaine and trehalose have been produced from acid whey through fermentation.

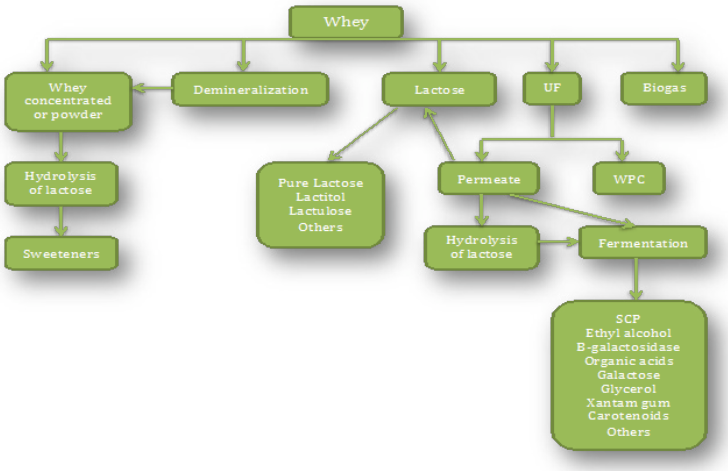

Figure 4.1. Utilization methods of whey still studied on and applied commercially (Siso, 1996).

5. NUTRIENTS IN WHEY AND NUTRITIONAL PROPERTIES OF WHEY PRODUCTS

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5.1. Measuring methods for determining whey parameters

The large quantity and the high dry-matter content are the main reasons for the necessity of managing whey that is the byproduct of making cheese, curd and casein. 80-90 liters whey is produced from 100 liters cheese milk. Approximately 50% of the dry-matter content of milk appear in the whey. The dry-matter content of whey is between 5.4% and 6.7% depending on the type of milk and milk product. Lactose is the main dissolved component of whey but it also contains whey protein, minerals, a small quantity milk fat, non-protein nitrogen compounds and vitamins. Whey protein can be educed from whey by heating (and acidification) and whey cheese can be produced from it (for example: urda, ricotta, brunost and ziger). Reducing the water content of whey highly extends the shelf-life of it. The creamed whey is traditionally condensed by a multiple-stage vacuum evaporation up to 48-62 weight percent dry-matter content. The main part of the milk-sugar in the condensate should be crystalized into alpha lactose monohydrate in order not to be sticky and hygroscopic. Then whey powder with 4-5% water content can be produced

by powdering and drying. If the whey powder is marketed in infant nutrition or medicinal nutrition, then its mineral content should be decreased (demineralization), especially in case of sour whey because of its high mineral content.

The salt content of whey can be reduced by ion exchange resins, electrodialysis or nanofiltration before powdering. By using different separating techniques, besides dehydration there is an opportunity to fractionation of the dry-matter content of whey. Whey protein can be separated from the small sized milk-sugar and minerals by a membrane process called ultrafiltration, so different protein content whey protein concentrates and isolates can be produced. The number on the label of the commerce whey protein concentrates (for example: WPC-35, WPC-80) shows the percentile protein content of the dry-matter content of the concentrate.

The growth of protein causes a proportionate lactose loss in the product. Whey protein isolates (WPI) are purer than concentrates; protein content: at least 90% of the dry matter. If the symmetry of whey protein is more than 70%, then ultrafiltration shall be combined with diafiltration in order to get the desired purity. In whey protein hydrolysates (WPH) the whey protein is hydrolyzed into peptides and amino acids so it becomes easily digestible than protein and can be consumed by children suffering from cow milk protein allergy. Fractionation of whey protein and peptides can be carried out with for example selective precipitation, chromatographic methods and membrane separation processes. Milk sugar can be broke up into galactose and glucose by using enzymatic or acid hydrolysis. The syrup produced by this process can be used to produce sweet dairy products or other food products. Its advantage is

that the products made from it can be consumed by lactose intolerant people too. Lactulose is an artificial sugar, produced during lactose isomerization where the glucose molecule is substituted by a fructose molecule. Lactulose cannot be broken up by lactase enzyme, it is fermented by the bacteria in the human guts: it has a prebiotic effect and prevents constipation. A sugar alcohol called lactitol can be also produced by the reduction of lactose. In order to decrease the energy content of food products lactilol is usually used to substitute sugar because of its sweet taste and low energy content (~9 kj/g). Its utilization in the human body is independent from insulin so it can be used in diabetic foods and as well as it has prebiotic effects. Lactobionic acid is produced by the oxidation of lactose and has a strong chelating characteristic. Ca-lactobionate's salt can be used as stabilizer in foods but it is also used in medicinal products in order to increase the calcium level of the human body. Galacto oligosaccharides (GOS) are one of the most important groups of prebiotics. GOS are not digestible carbohydrates that are constructed of 3-8 monomers. GOS can be found in their natural form in milk but also can be produced with the help of microbial enzymes in the presence of lactose. Depending on the GOS molecular chain length and the type of the monomers, several kind of GOS molecule can develop. D-tagatose monosaccharide can be obtained by enzyme or alkaline isomerization of D-galactose molecule that is an accepted sweetener. It has a sweetening power of 92% compared to that of sucrose, but only a small amount of it is absorbed in the small intestine. The major part of ingested D-tagatose is fermented in the colon by the indigenous microflora. Therefore D-tagatose has a low caloric value than sucrose. Apart from the above mentioned, whey can be used

in several fields. With the help of lactose yeast fungi that can be found in whey or its ultra filtrated liquid, can be fermented into ethyl alcohol.

Anaerobic treatment of whey results in methane that can be used as biogas. Milk sugar (as a carbon source) is used by yeast as substrate for constructing their own cells. The lactic acid that is produced by lactic acid bacteria from lactose is the source material of the polymer called polylactid acid (PLA). The polylactid acid is a kind of plastic that degrades biologically. Several kinds of organic acids, vitamins, amino-acids, xanthan gum and other products can be fermented from whey. Whey derivatives are also usually used by the pharmaceutical industry and the cosmetic industy. 185-190 million tons of whey is produced on the Earth in every year and this amount will keep increasing in the future. Due to its high dry-matter content whey has a significant biochemical oxygen demand so it would be the most environmental polluter by-product of the food industry if it is considered as waste water. Beyond its environmental issues, the necessity of the utilization of whey is essential because there are several components in it that are beneficial for the human organism. One of the steps of whey processing is dehydration. At the same time it is necessary to reduce the mineral content of whey, especially its NaCl content, in order to increase the product quality. These two operations can be done at the same time if whey is concentrated by filters. The tiny fat balls and bacterial cells can be removed from milk by microfiltration. Due to their sizes they cannot get across the membrane so they concentrate in the retentate while the other components of milk gets to the filtrate. Cold sterilization of milk can be carried out by microfiltration. In order to get high purity it is very important to separate the above mentioned

particles from the whey protein during the production of whey protein concentrates (WPC) and isolates (WPI).

The protein and milk sugar molecules can be separated from each other by an ultrafiltration membrane. The pore size (approximately 0.01 μm – 0.1 μm) and retaining of the membrane for the ultrafiltration changes widely, so the fractionation of proteins with different sizes can be carried out. Ultrafiltration is extensively used for producing high protein content concentrates. The Ca content of the retentate is high because a considerable part of the calcium links to the protein molecules. The permeate of the ultrafiltration contains lactose, non-protein nitrogen compounds (NPN compounds), small molar mass organic acids and ions. In the case of the production of products with more than 70% protein content of the dry matter, the ultrafiltration module shall be used in diafiltration mode. Adding fresh water to the concentrate helps to remove milk sugar and salts that results in higher protein purity.

Reverse osmosis is used for preconcentration of the permeate of milk, whey and ultrafiltration in order to increase the dry-matter content. The used membranes retain the univalent ions (K^+, Na^+, Cl^-) with the efficiency of 95%, so the filtrate is practically an ion free water and its biochemical and chemical oxygen demand can be decreased below 100 ppm. Reverse osmosis is used for up to 25% concentrates. The production of higher dry-matter content concentrate is limited by the continuous growth of the osmosis pressure of the retentate. Combining reverse osmosis and vacuum evaporation together is much more economical energetically than the concentration would be carried out by vacuum evaporation.

Electrodialysis is used to partially desalinate whey concentrates. With this method more than 90% of the NaCl content can be removed from the concentrate. During the separation non-pore cation exchange and anion exchange membranes are placed alternately between a cathode and an anode which form cell pairs. After it, desalination liquid is conducted into every "odd" cell from where the cations will move toward the cathode with negative charge and the anions will move toward the cathode with positive charge. Anion exchange membranes with positive charge will prevent the migration of cations, and vica versa, the anions will not be able to break through the cation exchange membranes. As a result of this the ions will concentrate in the "even" cells, while the partially desalinated liquid can be conducted from the "odd" cells.

5.2. Constituents of whey

Whey was discovered 3000 years ago. Milk was stored and carried in veal stomachs by our ancestors who recognized a natural process: the curdling. Later, the enzyme that causes this process, was also identified. During curdling two different products were produced: curd and whey. It led to the fact that whey is the byproduct of curd (in Hungary), cheese and casein production. Whey is rich in protein, minerals and vitamins. Its high nutritional value was discovered in this century, though, its healing effect was already known in Switzerland, Austria and Germany in the 18-19th century. Whey powder use shall be limited only because of its high lactose content, however, there are many type of foods in which it can be used largely. Acid curdling results in sour whey (curd production and soft cheeses), mixed curdling results in sweet whey (cheese production).

***Components of sweet whey and sour whey**:*

Components	Sweet whey	Sour whey
Total dry matter [%]	5,40-6,35	5,60-6,70
Milk sugar (lactose) [%]	4,1-5,0	3,8-4,6
Total protein [%]	0,8-1,0	0,8-1,0
Whey protein [%]	0,6-0,7	0,6-0,7
Milk fat [%]	0,2	0,2
Minerals [%]	0,50-0,60	0,50-0,85
Cl [ppm]	1000-1640	1000
Na [ppm]	300-460	450-600
K [ppm]	1050-1700	1200-1800
Ca [ppm]	250-500	800-1100
Mg [ppm]	40-100	80-120
P [ppm]	350-550	500-700
Vitamins		
Thamine [ppm]	0,4	0,4
Riboflavin [ppm]	1,4	1,4
Pyridoxine [ppm]	0,5	0,5
Cobalamin [ppm]	0,002	0,002
Nicotinic acid [ppm]	0,85	0,85
Folic acid [ppm]	0,05	0,05
Pantothenic acid [ppm]	3,4	3,4
Ascorbic acid [ppm]	2,2	2,2
Whey [%]	Traces, max. 0.1	Max. 0,8
pH	5,60-6,50	4,35-5,10
Conductivity [mS/cm]	4,7-6,4	8,4

The following chart shows the distribution of milk components between congealment and whey during cheese production:
(Percentage distribution of milk components in cheese and whey.)

Milk components	Gets into cheese out of 100 parts components	Gets into whey out of 100 parts components
Fat	87,7	12,3
Protein	72,0	28,0
Milk sugar	5,3	94,7
Ash	18,8	81,2
Total dry-matter	46,4	53,6

46.4% of the dry-matter that can be found in the source material gets into the principle product during the traditional processing. The bigger part of the valuable dry-matter is wasted. Cheese production is not an economical milk processing method because it is not reasonable that the natural products in the milk such as carbohydrate (94.7% of it), minerals (81.2% of it), protein (12.3% of it) and some part of the water soluble vitamins are wasted and thereby it becomes inaccessible for the consumers.

Components of whey Components	Whey (in 1000 ml)	Whey (in 1000 g)
Dry-matter (g)	*61*	*956*
Milk sugar (g)	*48/59**	*740/660**
Protein (g)	*8*	*125*
Fat (g)	*2*	*10*
Lactic acid (g)	*1/5**	*2/42**
Minerals (g)	*5/7**	*80/105**
Ca (g)	*0,5/1**	*7/20**
P (g)	*0,5*	*8*
K (g)	*1,4*	*20*
Na (g)	*0,45*	*9*
Cl (g)	*1*	*16*
Mg (g)	*0,04/0,8**	*1/2**
Zn (mg)	*0,3/2,3**	*10/60**
Fe (mg)	*0,9*	
Cu (mg)	*0,2*	*3*
Mn (mg)	*6/26*	*120/470*
Vitamins		
Thiamin (mg)	*0,4*	*5*
Riboflavin (mg)	*1,4*	*25*
Adermin (mg)	*0,5*	
Cobalamin (mg)	*1,5*	*25*
Niotinic acid (mg)	*2,0*	*8*
Folic acid (mg)	*50*	*220*
Pantothenic acid (mg)	*115*	
Ascorbic acid (mg)	*9*	*45*
pH value (mg)	*6,0/4,5**	

** the value in the sweet and the sour whey*

The following chart shows the amino acid compositions of and the differences among wheys, whey powders and mother's milk:

Amino acids (g/100g)	*Sweet whey*	*Sour whey*	*Sweet whey powder*	*Sour whey powder*	*Mother's milk*	*Daily need*
Tryptophan	0,013	0,016	0,205	0,251	0,017	0,25
Threonine	0,054	0,038	0,817	0,59	0,046	0,5
Izoleutin	0,047	0,038	0,719	0,581	0,056	0,7
Leutin	0,078	0,072	1,186	1,116	0,095	1,1
Lysine	0,068	0,065	1,03	1,008	0,068	0,8
Methionine	0,016	0,014	0,241	0,221	0,021	1,1
Cystine	0,017	0,014	0,253	0,211	0,019	1,1
Phenylalanine	0,027	0,025	0,407	0,386	0,046	1,1
Tyrosine	0,024	0,019	0,363	0,300	0,053	1,1
Valine	0,046	0,038	0,697	0,579	0,063	0,8
Arginine	0,025	0,021	0,375	0,327	0,043	
Histidine	0,016	0,015	0,237	0,23	0,023	
Alanine	0,039	0,033	0,598	0,506	0,036	
Aspartic acid	0,083	0,074	1,269	1,149	0,082	
Gluten acid	0,148	0,136	2,248	2,096	0,168	
Glycine	0,018	0,014	0,28	0,211	0,026	
Proline	0,052	0,045	0,786	0,699	0,082	
Serine	0,041	0,035	0,622	0,541	0,043	

Whey is rich in minerals since most of them are present in water in their disassociated form. The following chart shows the mineral compositions of whey, whey powder and mother's milk and the differences among them.

Minerals (mg/100g)	Sweet whey	Sour whey	Sweet whey powder	Sour whey powder	Mother's milk	Daily need
Ca	47	103	769	2054	32,2	800
Fe	0,06	0,08	0,88	1,24	0,03	12-18
Mg	8	10	176	199	3,4	300
P	46	78	932	1349	13,7	800
K	161	143	2080	2289	51,2	2000
Na	54	48	1079	968	16,9	2000
Zn	0,13	0,43	1,97	6,31	0,17	12
Cu	0,004	0,003	0,07	0,05	0,052	2
Mn	0,001	0,002	0,009	0,015	0,026	4
Se (µg/100g)	1,9	1,8	27,2	27,3	1,8	

Whey contains only small amounts of fat soluble vitamins due to its low fat content.

Vitamins (mg/100g)	Sweet whey	Sour whey	Sweet whey powder	Sour Whey powder	Mother's milk	Daily need for men	Daily need for women
Ascorbic acid	0,1	0,1	1,5	0,9	5,0	60	60
Thiamine (B_1)	0,036	0,042	0,51	0,622	0,014	1,4	1,2
Riboflavin (B_2)	0,158	1,14	2,208	2,06	0,036	1,7	1,6
Niacin	0,074	0,079	1,258	1,16	0,177	16	14
Pantothenic acid	0,383	0,381	5,62	5,632	0,223	8	8
Vitamin B_6	0,031	0,042	0,584	0,62	0,011	2	19
Vitamin B_{12}	0,28	0,18	2,37	2,5	0,045	0,0004	0,0004
Vitamin A (IU)	12	7	30	59	241		
Retinol	3	2	8	17			

Milk sugar or else lactose is a disaccharide that consists of galactose and glucose. Its name is originated from the Latin word for milk and the "-ose" (means sugar) suffix. A β-D-galactose and a D-glucose molecule link together by a β 1-4 glycosidic linkage. Both monosaccharides can be found there in a pyranose ring shape. Within the dry-matter content of whey, milk sugar represents the most part (approximately 70%). There is an amount of lactose equal to 2-8% in the dry-matter content of milk. Milk sugar is a kind of nutrient that cannot be processed by the human body in its original form. However, the lactase enzyme found in the small intestine make

it suitable for absorbing by the degradation of the double sugar molecule, so it may become a useful energy source.

After the transformation from double sugar molecule into single sugars, grape sugar enters into the bloodstream and can be utilized immediately, while galactose transforms in the liver. One of the beneficial effects of lactose is that its glycemic index is half than glucose has and will not affect on blood sugar level so much. Lactose is used by intestinal bacteria as nutrient source. They produce lactic acid and short carbon cycle fatty acids (SFCA), prevent the reproduction of harmful (proteolytic and rotting) bacteria by decreasing the pH value of the large intestine. The low pH value increases the solubility of several minerals (for example: calcium and magnesium) associating with the increase of osmotic pressure of intestinal content by the activity of bacteria. These two processes improve the effectiveness of the absorbtion of minerals. Lactose intolerancy occurs if the lactase enzyme is missing or its low level causes clinical symptoms (bloat, spasms, and diarrhea). Whey is an important calcium source. Calcium is the most plentiful mineral found in the human body, together with phosphorus and magnesium they play an important role in the construction of bones and teeth. There is 3-4 times more potassium can be found in whey than sodium. The high Na: K ration may cause high blood pressure but the K content of whey can counterbalance the extreme Na intake. Water soluble vitamins, especially B vitamins, constitute the bigger part of vitamin content of whey due to their low fat content. Within the B vitamins, riboflawin (B2) and cobalamin (B12) concentration is outstanding. Riboflawin causes the greenish-yellow colour of whey.

5.3. Structure and functionality of whey proteins

There is not just genuine protein, but non-protein nitrogen compounds (NPN-compounds, for example: peptides, free amino acids, carbamide, creatine, orotic and ammonium salts) can be found in whey. Whey proteins form a rather heterogeneous group of proteins. The different whey protein fractions have very few common characteristics. One of the most remarkable ones is that they remain soluble when the casein precipitate from their solution.

Whey protein digestibility is between 94-100%. The values of the different whey protein fractions originated from the whey protein of cow's milk:

- β-lactoglobulin 44-58%
- α-lactalblumin 13-22%
- glycomacropeptides 12-20%
- serum Albumin 4-8%
- immunoglobulins 8-15%
- lactoferrin 2-3%
- lactoperixodase 0.5%

Whey protein is a complete, good quality protein with rich amino acid profile. It contains the whole spectrum of amino acids (AA), from the essential amino acids (EAA) to the branched-chain amino acids (BCAA) that play a key role in tissue growth and correction. Leucine is an important BCAA that has a key role in insulin and glucose metabolism that was discovered recently. Whey protein contains larger quantities of EAA and BCAA amino acids than other protein sources (soy, corn, wheat) and the human body can absorb and use them

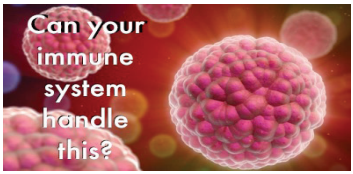
efficiently. Due to the high concentration of EAA and BCAA, whey helps the human body to retain muscle tissue. It is useful especially for old people, for those who live active life, for those who want to loose weight and for those who want to maintain their actual body weight. If old people maintain their thin body weight or increase it, they can avoid the unwanted changes of aging within their body. Furthermore, diseases like heart diseases, stroke, diabetes etc. can be prevented. Whey protein decreases the chance for sarcopenia to the minimum because it stimulates the protein synthesis after meals and constrains the protein loss of the organism.

Consuming whey gives an extra boost for the synthesis of muscle proteins that is beneficial for people doing physical activities like stay power training. If old people consume 10-20 gram whey after doing exercises, it will increase protein synthesis thanked to its high EAA amino acid and leucine content. So, it can be said that whey might play an important role in body weight development. According to the research results, the appropriate calcium intake may prevent fatness and can help to lose weight. As for epidemiological studies, low calcium intake will highly increase the chance for fatness.

Lactose is the primary sugar component of whey products. It has a low glycaemic index so it might help to lose weight. Lactose has only a minimum effect on blood sugar level and insulin response, so it is ideal for those who are suffering from type 2 diabetes. Protein causes satiety and may reduce body fat and body weight by the modulation of energy intake. Whey can reduce food intake better than other protein sources like soy, egg or meat. That is why whey consumption is ideal for those who want to consume foods with high protein and

low carbohydrate content. Branched-chain amino acids and leucine play a unique role in metabolism control, help in fat loss and the development of thin muscle tissues after doing exercises. Many sportsmen consume whey protein because of its branched-chain amino acid (BCAA) content. During staying power training the BCAA demand of the human body increases. Whey protein is ideal for replacing BCAA that helps protein synthesis and muscle development during relaxation. Whey proteins are very effective in increasing the protein synthesis of muscles because their amino acid profiles are almost the same than the amino acid profiles of the skeletal muscles. In addition, due to the high amino acid content (EAA) whey proteins effectively stimulate the protein synthesis of adult people's muscle.

Whey proteins have an exceptional ability to optimize the immune system in several ways. In the first place it increases the glutathione level (GSH) in several tissues. GSH is the antioxidant protector of the organism. It protects the cells from the damages of free radicals, contaminaton, poisons, infections and ultra violet radiation. GSH level shows a decreased level in case of HIV, cancer, chronic fatigue syndrome and other immune system diseases. GHS level keeps decreasing during aging and may partly responsible for the development of Alzheimer's disease, cataracts, Parkinson's disease and arteriosclerosis. That is why whey protein rich nutrition is essential not only for those people who are suffering from some diseases but for those in every age groups too who are healthy.



The following components of whey are also have good effects for the function of the immune system:

• Cysteine – amino acid, it can be found in whey protein in large quantities. It is the one of the materials that responsible for GHS production within the cells.

• Lactoferrin – it has an immune modulating effect against microbes and poisons, gives protection against certain viruses, for example hepatitis, cytomegalovirus and flu.

• Immunoglobulins – increase the passive immunity thereby they give protection for infants. In case of adults, they increase the immune system activity.

• BCAA (branched-chain amino acids) – produced by muscles to produce glutamine, which is one of the precursors of GHS and other important immune components.

Whey protein contains glutamine too that prevents fatigue and overtraining, since it provides "fuel" for cell division. Lactoferrine is a kind of protein can be found in whey protein and has an iron binding characteristic. Lactoferrine belongs to transferrins. This group of compound is responsible for that iron binds to the red blood cells. Usually both men's and women's muscular strength shows a regression of 20-40% at the age of 70-80. It is caused by sarcopenia among the 30% of those over 60 years old. Sarcopenia causes not just the weakness of muscular strength but the decline of muscle mass. The main

reasons for the development of sarcopenia are: low protein intake, low calorie intake, change in protein synthesis and the reduced physical activity. Protein synthesis after meals is lower in the case of healthy old people than healthy young peolple. Whey stimulates better protein synthesis after meals than casein that is why it reduces muscle mass loss. Whey protein contains β-lactoglobulin, α-lactalbumin, immunoglobulins, β-globulin, lactoferrin, lactoperoxidase and glycomacropeptide that are biologically active materials. Proteins can be found in whey have the following characteristics: antioxidant, anticancer, antibacterial, antimicrobial and antiviral. Furthermore, they have beneficial effects against high blood pressure and reduce cholesterol level. Some proteins in whey stabilize vitamins and minerals that is why they play an important role in the metabolism of nutrients.

According to scientific achievements, whey proteins and peptides help digestion and the function of intestines, furthermore, they increase the production of glutathione and the function of the immune system. Consequently, whey protein intake may increase the general state of health of the organism in several ways.

The following chart sums up the beneficial biological effects of protein fractions of whey protein:

β-lactoglobulin	B- Lactoglobulin provides 50% of the protein content of whey protein. Although, biological role of β-lactoglobulin is not comletly clear yet, it is sure that it stabilizes minerals (for example zinc and calcium), liposoluble vitamins (for example vitamin A and E) and lipids, so by these it plays a very important biological role. Besides that, it contains branched-chain amino acids in large quantities.
α-lactalbumin	α- laktalbumin provides 50% of the protein content of whey protein and has characteristic effects like anticancer, antimicrobial and immunostimulant. α- lactalbumin increases the serotonin production that improves mood. Reduces the cortisol (stress hormone) level of the organism.
Peptides	Peptides that can be found in whey reduces the cholesterol level, the blood pressure and protects against certain types of cancer.
Albumin	Whey protein contains 5% bovine serum albumin that has antioxidant and antimutagenic effect. It plays an active role in stabilizing free fatty acids and forms chelates with pro-oxidant transition metals.
Immunoglobulins	Immunoglobulins (for example IgA, IgM, IgE and IgG) help the passive immune function.
Lactoferrin	Lactoferrin is a protein that binds to iron that has many role in the human body. Lactoferrin has anticancer, antimicrobial, antiviral, antibacterial, antioxidant, anti-inflammatory and immune stimulant effects.
Lactoperoxidase	Lactoperoxidase is an enzyme that degrades hydrogen peroxide and has an antibacterial effect. Lactoperoxidase is used as a preservative and used in toothpastes against decay. It has antioxidant and immunostimulant effects.
Glycomacropeptides	Glycomacropeptides decrease appetite and have antiviral, anticancer, immunostimulant effects, but also good for lowering blood coagulation, protect against high blood pressure and tooth decay.

In case of healthy people 20-25 gram whey protein isolate (WPI) or concentrate (WPC) intake is optimal per day. It can be consumed more than twice of the previously mentioned portion by sportsmen, since they require more protein for the regeneration of their muscular tissues. Additional portion of protein should be consumed by those who are suffering from Crohn disease, who take part in cancer therapy, who are suffering from severe burns and patients after surgery. The aim is that 20-30% of the total daily protein intake should be come from whey protein. Whey protein powder can be easily mixed into shakes, yoghurts, cheeses, juices, sports drinks, smashed potato or oatflakes. It is also can be used as protein supplement in meatloaf, soups, sauces and instant pudding. There is an increasing demand for the functional nutritions in highly developed countries. These kinds of nutritions have some additional positive effects for the consumers' organism beyond their basic feed value. Sweet whey powder can be used in ice screams, puddings, cakes, biscuits, bread, bakery products, chocolates, caramels, juices, soft drinks, dried soups, sauces, meat products, margarines. Sour whey powder can be used in juices, fermented milk products, cheeses, dressings, bread, crackers and some meat products. If whey powder is marketed as ingredients of infant nutrition or medicinal nutrition, demineralization of the whey might be required, especially in the case of sour whey, which contains higher mineral content. Both fermented and alcohol free whey drinks can be produced from whey or from its certain fraction. If whey is mixed with some juice or pulp, it results in tasty drinks that combine the beneficial effects of fruits and whey for the human health.

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6. WHEY PRODUCTS IN MARKETS: DEFINITION, COMPOUND AND FUNCTIONS

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6.1. Sweet Whey Powder

Sweet whey powder, in accordance with TS 11860, is defined as the product obtained by the way that remaining liquid compound of which varies in accordance with cheese species and making technique is pulverized just after casein and fat are separated from each other as curd using rennet during cheese making (TSE, 1995).Sweet whey powder is generally obtained by the way that fresh whey formed in production of cheese species such as Swiss, Mozzarella, Cheddar is pasteurized and dried. Sweet whey powder contains all components of fresh whey in the same rate, except water. It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for sweet whey powder is shown on Table 6.1.

Table 6.1. Compound for sweet whey powder.

Component	Amount (%)
Protein	11.0-14.5
Lactose	63.0-75.0
Fat	1.0-1.5
Ash	8.2-8.8
Humidity	3.5-5.0

6.2. Acid whey powder

Acis (sour) whey powder, in accordance with TS 11860, is defined as the product obtained by the way that liquid obtained by being filtered from curd in accordance with its own technology, which is formed as a result of the fact that milk is precipitated by acid (TSE, 1995). Sour whey powder is obtained by the way that fresh whey in production of cheese species such as Ricotta, cream cheese and cottage is pasteurized and dried. Sour whey powder contains all components of fresh whey in the same rate, except water.

It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for sour whey powder is shown in Table 6.1.

Table 6.2. Compound for sour whey powder

Component	Amount (%)
Protein	11.0-13.5
Lactose	61.0-70.0
Fat	0.5-1.5
Ash	9.8-12.3
Humidity	3.5-5.0

6.3. Delactosed whey powder

Delactosed whey powder is obtained by the way that lactose is hydrolyzed and removed from whey. Lactose rate in dried powder product does not pass limit of 60%. Removal of lactose is performed by physical separation such as filtration and precipitation or enzymatic hydrolysis of lactose into glucose and galactose. It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-9 months. Compound for delactosed whey powder is shown on Table 6.3.

Table 6.3. Combination for delactosed whey powder.

Component	Amount (%)
Protein	18.0-24
Lactose	52.0-58.0
Fat	1-4
Ash	11-22
Humidity	3.0-4.0

6.4. Demineralized whey

Demineralized whey (or mineral-reduced whey) is performed by removal of minerals from pasteurized whey to a certain extent (30%, 50% and 90%). Demineralization process is applied with separation techniques such as ion exchange, nanofiltration, diafiltration and/or electro-dialysis. Demineralized whey must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for mineral-reduced whey powder is shown on Table 6.4.

Table 6.4. Compund for mineral-reduced whey powder.

Component	Amount (%)
Protein	11.0-15
Lactose	70.0-80.0
Fat	0.5-1.8
Ash	1.0-7.0
Humidity	3.0-4.0

Dairy products are generally used in nutrients for children, processed foods, enrichment of dairy products, bakery products and sweet products. They are especially common to get used in baby nutrition, milk and formulations in development and growth. They are also used in mixtures of powdered beverages. In addition, they are utilized especially in enrichment of yoghurt based dairy products. They are also used in new mixtures; “Super Cereal Plus” within the body of World Food Programme for the management of hunger experienced and witnessed in middle or high level on international scale.

6.5. Whey protein concentrate 34% protein (WPC34)

Whey protein concentrate is obtained by removal of non-protein components from pasteurized whey and final product has protein in rate of 34%. It is produced within WPC34 membrane separation technique. It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for whey protein concentrate (WPC34) is shown on Table 6.5.

Table 6.5. Compound for whey protein concentrate 34% protein WPC34).

Component	Amount (%)
Protein	34.0-36.0
Lactose	48.0-52.0
Fat	3.0-4.5
Ash	6.5-8.0
Humidity	3.0-4.5

6.6. Whey protein concentrate 50% protein (WPC50)

Whey protein concentrate is obtained by removal of non-protein components from pasteurized whey and final product has protein in rate of 50%. It is produced within WPC50 membrane separation technique. It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for whey protein concentrate (WPC50) is shown on Table 6.6.

Table 6.6. Compound for whey protein concentrate 50% protein (WPC50).

Component	Amount (%)
Protein	50.0-52.0
Lactose	33.0-37.0
Fat	5.0-6.0
Ash	4.5-5.5
Humidity	3.5-4.5

6.7. Whey protein concentrate 60% protein (WPC60)

Whey protein concentrate is obtained by removal of non-protein components from pasteurized whey and final product has protein in rate of 60%. It is produced within WPC60 membrane separation technique. It must be stored and

transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for whey protein concentrate (WPC60) is shown on Table 6.7.

Table 6.7. Compound for whey protein concentrate 60% protein (WPC60).

Component	Amount (%)
Protein	60.0-62.0
Lactose	25.0-30.0
Fat	1.0-7.0
Ash	4.0-6.0
Humidity	3.0-5.0

6.8. Whey protein concentrate 75% protein WPC75)

Whey protein concentrate is obtained by removal of non-protein components from pasteurized whey and final product has protein in rate of 75%. It is produced within WPC75 membrane separation technique. It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for whey protein concentrate (WPC75) is shown on Table 6.8.

Table 6.8. Compound for whey protein concentrate 75% protein (WPC75).

Component	Amount (%)
Protein	75.0-78.0
Lactose	10.0-15.0
Fat	4.0-9.0
Ash	4.0-6.0
Humidity	3.0-5.0

6.9. Whey protein concentrate 80% protein (WPC80)

Whey protein concentrate is obtained by removal of non-protein components from pasteurized whey and final product has protein in rate of 80%. It is produced within WPC80 membrane separation technique.

It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for whey protein concentrate (WPC80) is shown on Table 6.9.

Table 6.9. Compound for whey protein concentrate 80% protein (WPC80).

Component	Amount (%)
Protein	80.0-82.0
Lactose	4.0-8.0
Fat	4.0-8.0
Ash	3.0-4.0
Humidity	3.5-4.5

Whey concentrates (WPC) having different protein rates (34-80%) have been used commonly in baby food formulations especially in Eastern Asia and China markets in recent years. Apart from that, WPC can be used in sports drinks as nutritional supplement; as component especially in body-muscle development and weight and kilo management of athletes and sportsmen in recent years.

6.10. Whey protein isolate

Whey protein isolate (WPI) is obtained by removal of non-protein components from pasteurized whey and final product has protein in rate of 90%. It is produced within

WPC90 membrane separation technique. It must be stored and transported in storage conditions at a temperature lower than 27°C and humidity rate lower than 65%. Shelf life of product also varies between 6-12 months. Compound for whey protein concentrate (WPC90) is shown on Table 6.10.

Table 6.10. Compound for whey protein isolate.

Component	Amount (%)
Protein	90.0-92.0
Lactose	0.5-1.0
Fat	0.5-1.0
Ash	2.0-3.0
Humidity	4.5

6.11. Lactoferrin, lactoperoxidase (LP), glycomacropeptide (GMP)

Lactoferrin is a glycoprotein consisting of a single polypeptide by bonding of N-glycosidic bond and two glycans. Average lactoferrin amount in cow's milk is 10mg/L and lactoferrin is in much more amounts in whey protein products. For example; 30-100 mg lactoferrin is included in 1 litre of sweet whey. Lactoferrin can be produced commercially within various techniques such as chromatography and membrane technologies. Lactoferrin is not only amino acid source but also plays remarkable role in many biological functions required for our body. Compound for lactoferrin is shown on Table 6.11.

Table 6.11. Compound for lactoferrin.

Compound	Amount (%)
Protein	>90.0
Lactoferrin	>90.0
Humidity	<5
Ash	<1.5

Iron, due to the fact that it is an essential element for development of almost all pathogenic microorganisms, is removed from medium by lactoferrin and thus growth of bacteria is prevented. Besides, it is also reported that lactoferrin is antiviral, antioxidant, antifungal and active agent against cancer. It has been proved scientifically that lactoferrin has antimicrobial activity; so, it is effective against pathogens such bacteria, virus and fungi. It has been detected in researches and studies that it prevents development of some organisms containing especially ***Escherichia coli, Salmonella enteritidis, Klebsiella pneumonia, Camplobacter jejuni*** **and** ***Listeria monocytogenes*** substantially and affects plasma glutation concentration of HIV patients in significant levels.

Lactoferrin is accepted to be multi-functional food additive due to its antimicrobial and prebiotic properties. Lactoferrin is recommended to be used as additive in foods, baby foods, foods used in sportsman nutrition, chewing gums. It is also reported that lactoferrin and activated lactoferrin are proper natural protectors for meat industry, lactoferrin does not change colour, flavour and appearance of meat in which it is added, lactoferrin applied to meat also prevents formation and development of bacteria that are pathogen and spoiling factor after production. It has been detected that lactoferrin has improved microbial quality of Tekirdağ meatball, stop or inhibit

development of E. coli O157:H7 when lactoferrin is used by itself or with chelating agents in fermented meat products; and *Pseudomonas fluorescence, E. coli O157:H7, Salmonella typhimurium* and *Campylobacter jejuni* in fresh meat. Similarly, it is indicated that it removes microorganisms effectively, which are held on carcase surface when it is applied on cow carcases in weight in 2% or lower rate. It has been determined that lactoferrin prevents oxidation of unsaturated fatty acids in soybean oil powder and increases storage life of product. It has also been determined that lactoferrin-derived bioactive peptide both prevents development of spoiling factor yeasts in wine and increases shelf life of wine. Lactoperoxidase (LP) is a glycoprotein in weight of 77.5 kilodaltons of molecules. LP is a natural enzyme having antimicrobial feature in sweet whey between 1-30mg/L. LP has shelf life of almost more than 6 months in 2-8°C. Average compound for lactoperoxidase is shown on Table 6.12.

Table 6.12. Average compound for lactoperoxidase.

Component	Amount (%)
Protein	92
Humidity	5
Ash	3

Biological significance of LP is based on the fact that it is included in natural host defence system against pathogenic microorganisms. For this reason, it protects gastrointestinal system of newborn infants against pathogenic microorganisms. It has been proved in scientific researches and studies that LP causes deterioration of various carcinogens, protects animal cells against peroxidative effects and is effective also against poliovirus in addition to its antimicrobial effect. Besides, it is

also used in oral and skin care products in prevention of gum infections and dental caries. It has been detected in clinical researches and studies that LP is effective in reduction of dental caries and infections in the event that toothpastes contain LP. LP has also been determined to be used in mouth liquids, shampoos and acne applications.

LP and low-temperature applications also assist to preserve nutrition and quality charateristics of foods such as salad sauce, beverages and desserts that are sensitive to high temperature. LP system is also used in order to delay inhibition of *Listeria monocytogenes* on surface of fresh fish steaks and meats, and development of *E.coli* and *S. typhimurium* in milks prepared for babies. Glycomacropeptides (GMP) are obtained from fresh whey using ion exchange and membrane technology. Compound for Glycomacropeptide is shown on Table 6.13.

Table 6.13. Compund for Glycomacropeptide.

Component	Amount (%)
Lactose	<1
Fat	0.6±0.2
Ash	6.3±0.2
Humidity	6.0±0.2

Glycomacropeptide, known as also caseinomacropeptide, forms as a result of hydrolytic activity of chymosin enzyme on κ-casein during cheese production and constitutes almost 10-20% rate of whey proteins. Enterotoxins released by *Vibrio cholerae* and *E. coli* are excreted out of intestinal system by GMP. It is also determined that GMP can also be used as prebiotic and stimulates development of bifidobacteria, a type of probiotic bacteria.

6.12. Milk solids (Permeate)

Permeate defines a product containing maximum ash in 27%, protein in 10% and minimum lactose in 59%. Permeate is utilized as milk component in foods and feeds (permeate that can be used in animal feeds and human nutrition) in compliance with type of utilization. Compound for permeates is shown on Table 6.14.

Table 6.14. Compound for permeates.

Component	Permeate that can be used in animal feeds (%)	Permeate that can be used in human nutrition (%)
Protein	3.5-4.0	3.0-8.0
Lactose	82	65-85
Fat	0.2	1.5 (max)
Ash	8.5	8.0-20.0
Humidity	4.0-5.0	3.0-5.0

Permeate that can be used in animal feeds is used in nutrition of dogs, cats, chickens and other animals, particularly; nutrition of pigs in high rates. Usage of it in foods occurs as lactose and protein source especially in bakery products and cake mixtures. It reduces usage rate of sucrose or corn syrup in bakery products. Furthermore, these whey products are also used in development medium of yeasts.

6.13. Mineral concentrated whey or reduced lactose whey

Mineral concentrated whey is obtained by removal of some portion of lactose from whey. Mineral concentrated whey can be utilized as an ingredient having very high functional property since spray-drying technology is used for this purpose. It is also called as reduced lactose whey. Compound for reduced lactose whey powder is shown on Table 6.15.

Table 6.15. Compound for reduced lactose whey powder.

Component	Amount (%)
Protein	18.0-24.0
Lactose	50.0-60.0
Fat	2.5 (max)
Ash	14.0-22.0
Humidity	3.0-5.0

Mineral concentrated whey is utilized in food formulations in order to provide texture, flavour, solubility and nutritive feature. They have quite high solubility; they are preferred and used in food sector quite a few due to the fact that they are heat resistant and economical, minimize various texture problems based on lactose crystallization, have high protein and mineral compounds, provide desired flavour and slippery structure in foodstuffs. It is commonly used especially in dairy products, meat products, sweets, bakery products, snacks, soups, sauce, and frozen desserts.

6.14. Dairy minerals

Calcium, one of basic minerals of milk, is a mineral included in milk naturally in form of calcium phosphate. Products of dairy minerals are obtained by precipitation of calcium phosphate from whey permeate obtained through ultra-filtration in proper concentration, pH, duration and temperature. Whey based products take place among products that are rich in milk calcium and economically favourable. Compound for milk calcium minerals and concentrates is shown on Table 6.16.

Table 6.16. Compound for milk calcium minerals and concentrates.

Component	Amount (%)
Calcium	23-28
Phosphor	13.00-14.00
Rate for Ca:P	1.7:1-2:1
Total minerals	76.0-77.5
Humidity	4.0-7.0
Protein	1.0-8.0
Lactose	1.0-6.0

Milk calcium is a mineral natural in 100% and also includes phosphor and magnesium apart from calcium. Absorption of calcium included in dairy products occurs easily especially in intestinal system. Milk calcium minerals and concentrates are used in tablet or capsule as nutritional supplement. These products are used in foods and beverages enriched in calcium, especially in bakery products, sweets, meat products fruit juices and milky beverages.

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7. AREAS OF USAGE FOR WHEY

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Whey is the green liquid remaining as a result of the fact that milk is processed into cheese, which includes serum proteins such as lactalbumine and lactoglobuhn among milk components and lactose, fat, mineral matter and vitamins in different amounts. Utilized milk in amount of 70-90% remains as whey though it differs in accordance with cheese-making. In a more extensive meaning, final product obtained from three sources is accepted to be whey; residue of cheese industry.

We can gather obtainment methods of whey within the titles in the following:

• "Sour cheese whey" or "acid cheese whey" obtained as a result of the fact that milk is soured by itself or it is coagulated by adding acid.

• "Sweet cheese whey" or "yeast cheese whey", residues of cheese obtained as a result of the fact that milk is coagulated by yeast enzyme.

• "Kashar whey" or "boiling water" arising from the fact that teleme is boiled during kashar cheese-making.

• The one arising as a by-product in casein production is also called “technical whey”. In casein production, milk is generally coagulated with an inorganic acid; for example; hydrochloric acid.

Whey compound differs in wide limits, which is obtained depending upon many different factors such as milk quality and compound processed for cheese production, cheese production technique, amount and quality of yeast used in coagulation, temperature or duration applied in coagulation and decomposition form of coagulum. Whey is known to be sweet whey, which is obtained as by-product from firms producing hard, semi-firm or soft cheese and rennet casein and its pH is between 5,9-6,6. Whey obtained by production of settled casein through mineral acid is an acidic Whey and its pH is between 4,3 and 4,6. Called as “Lactoserum” in French, “Whey” in English, “Molke” in German, W is used in production of concentrated W, W powder, lactose reduced and demineralised whey, whey concentrate, whey protein isolate and various pure proteins in addition to whey beverages being applied to technical methods such as ultrafiltration, microfiltration, reverse osmosis, ion exchange.

Whey can be used in animals directly and it can also find utilization opportunity in many fields by being dried. This dried water is known as Whey powder. Drying process is performed in spray drier. Moisture content of obtained product varies between 12-15%.

Sweet whey powder, in accordance with TS 11860, is defined as product obtained by pulverization of remaining liquid compound of which varies in accordance with type of cheese and making technique after casein and fat are dissolved

as coagulum during cheese-making by usage of rennet. Sore (Acidic) whey powder, in accordance with TS 11860, is also the product obtained by pulverization of liquid obtained by filtering from precipitation in accordance with technology, which is formed as a result of precipitation of milk by acid. Whey powders are used in different fields in food industry and they are most widely used to flavour foods. It is utilized from this property of whey powder particularly on appetizer covering, and also pressed appetizers, cheese based sauces, soups, potato chips, salty spices and salty biscuits. Whey powder is used in food industry in many products such as sweets, bakery products, meat products, soups, sauces, beverages. Besides, it is also preferred as carbohydrate source since it is a cheap and high quality protein source in animal nutrition. Consumption in liquid form, direct usage ofwhey is performed in two ways. First one is utilization of it as an animal feed mixed into drinking water of farm animals without applying any other process. Whey contains not only protein and lactose in high amounts but also some minerals and water-soluble vitamins; so, it has a great nutritional value. Another way of direct usage of whey in liquid form is the fact that it is provided inside soil as fertilizer. However its usage in this way is limited due to its high salt content and problems encountered in transportation and it may cause salt storage in too high amounts in soil. Quality of fresh whey is increased by pulverization or concentration and this may both extend shelf life and provide facilities in transportation. It is possible to utilize whey in different ways in accordance with purpose.

Protein fraction of whey constitutes 18-20% amount of milk total nitrogen. Beta-lactoglobulin is the basic milk serum protein and alfa-lactalbumine constitutes 20% amount of

total serum proteins or 2-5% amount of total milk nitrogen content. Whey proteins are heat-sensitive so they denature and precipitate rapidly by heating. Whey protein concentrates and protein isolates are used widely in food industry due to their functional and nutritional properties. The most significant ones of these proteins are beta-lactoglobulin and alfa-lactalbumine, and they constitute approximately 70% amount of whey proteins.

Levels and properties of these proteins vary in accordance with processing technology. Whey proteins have started to become popular and known as functional and nutritional food product since 1980. Because, whey proteins have become significant in their properties such as gel formation, water binding, emulsification and foam generation. Usage of milk protein concentrates in nonstandard cheese types such as cheese types utilized in bakery, ricotta, feta and Hispanic cheese, processed cheese and other fresh cheese types is also wide. Other fields in which milk protein concentrates are widely utilized are productions of desserts, bakery products, low-fatty products, dairy based dry products, milky beverages and yoghurt texture increasers. Milk protein concentrates are also used in productions of whole milk powder and skimmed milk powder. Fermented milk not including lactose can also be produced by using milk protein concentrates.

Whey milk products are utilized in products as ingredient such as yoghurt and ice-cream. Materials taking place in Whey and its compound are also utilized as value-adding ingredient in many food products such as baby foods, bakery products, meat and fish products. Furthermore, whey has many applications in nutrition, too.

Nowadays, there is a gradually increasing attention to whey as a functional food within its positive effects on health. There is also an increasing attention to usage of whey and its components as functional ingredient in dietary and healthy products such as clinical and dietary food products. Bioactive whey components as much as bioactive proteins are also utilized increasingly in pharmaceutical industry as much as in nutrition field.

Whey products over 25% are utilized in human nutrition in EU. It is estimated that usage of whey and its products in human nutrition will increase in remarkable rates in near future. Whey industry develops new applications for whey and whey ingredients in order to increase variety of healthy food products. Whey and whey products have a wide usage area for different purposes in many fields, particularly; agriculture, food, biotechnology.

There are many opportunities for usage of milk protein concentrates. Patent and other research activities are performed by firms and universities. The following points are emphasized on in these researches and activities:

- Formula functionality optimization,
- Proper recipe classification,
- Flexible labelling principles,
- Adjustment of product quality, shelf life and casein rate.
- Nutritional and functional benefits of these products.

Usage of Whey in Food Industry

Whey has a very wide area of usage in food industry. Although not known widely in our country, various alcoholic or soft beverages are produced using whey. Because of the fact that Whey proteins provide structure and moisture control within its acid stability and increase emulsion and foaming properties, they are used in production of sweets and many types of dessert and sweet foods like cake and chocolate. Whey proteins, due to the fact that their emulsion capacity and stability are high, are used in production of the products such as cream, mayonnaise, spreadable cream cheese, meat and salad sauces. Additionally, whey proteins are used as stabilisers, which have property of high gelling in cream-soups, meat sauces and similar foods. Whey concentrates are used in order to develop structure in Quark, Cottage and processed cheese types, increase efficiency in Cheddar cheese, obtain more viscous product due to their water binding property in making yoghurt. Whey proteins have area of usage in meat industry, too due to their properties of water holding capacity, forming stable emulsion and fattening. Whey powder is used in meat products such as sausage and salami, and some sauces.

Because of lactose in high amounts it contains, whey powder is used in bakery products such as cake, biscuit and pastry rather than skimmed milk powder. Whey proteins are also utilized in baby food production.

Usage in Production of Some Dairy Products

Usage in yoghurt production: One of the products is yoghurt in which whey is most widely used in dairy industry. Whey protein concentrate (WPC) and whey powder are used in order to provide yoghurt a tight structure, decrease water-release situation and give a different aroma. Yoghurt is a fermented dairy product and it is formed within the fact that *Streptococcus thermophilus* and *Lactobacillus bulgaricus* bacteria ferment milk.

Milk transforms from liquid into yoghurt curd in gel form at the end of fermentation. The most significant point is the form of yoghurt curd obtained when it comes to yoghurt. It is remarkable point taken into consideration in this phase that incubation temperature, significant for a good yoghurt curd, must be 42-43 ^{0}C. Indeed, the fact that this temperature is low causes to extend incubation period and slow down acidity development. The fact that acidity development is slow causes serum release risk for yoghurt and weak curd formation. Technological methods as much as traditional methods are used to prevent yoghurt serum from releasing and form tight curd. They include methods such as boiling milk, adding milk powder, adding buttermilk powder, whey powder and concentrate, adding serum protein concentrate, adding caseinate, evaporation, membrane filtration method, thickening and adding stabiliser material. It is a widespread application that products obtained from W are used in yoghurt production. These are whey concentrate (WC), whey powder (WP), serum protein powder (WPP), serum protein concentrate (WPC), hydrolyzed whey concentrate (WPH) and whey isolate (WPI).

Whey powder used in yoghurt production is used to increase tightness of yoghurt curd and its viscosity and prevent

yoghurt serum from releasing. Whey powder can be added in milk in rate of 0.6-4% in order to make yoghurt curd hard and prevent whey from releasing in yoghurt making. In this way; more acetaldehyde is formed in yoghurt structure, viscosity increases, sensory properties develop and whey release tendency of yoghurt decreases. Besides, it is also stated that addition of WPC provides high elasticity and water holding capacity.

It is recommended that the amount to be used does not extend 1-2% although it is stated that it can be added up to 4%. More amounts than this level can lead to taste and aroma defects. It must be paid special attention to temperature applied to milk while especially whey concentrate is used in yoghurt production. Indeed, high long-term heat to be applied (5-20 minutes at 85-90 ^{0}C) causes precipitation of serum proteins in whey. Either an independent heating treatment must be applied with milk or long-term heating treatment should be applied in low temperature in order to prevent this situation.

Usage in drinking milk: Protein amount of milk gets increased by addition of whey protein in order to reduce aroma loss arising from low fat amount in dietary drinking milk including fat in low amount. Besides, lactose and whey protein are used in cow's milk in order to make cow's milk similar to breast milk. When whey proteins are added into fat-reduced milk (fatty milk in 1.5% rate), weak flavour and aroma arising from fat reduction can have normal milk flavour within the effect of increasing protein.

Usage in butter production: Fat rate in whey vary in accordance with used types of milk and applied technology. If fat rate is below 0.2%, butter production made from this kind of whey is not economical. It is possible to make separation until fat in 0.05% rate remains from whey using cream separators. Cream obtained in this way is utilized in butter production.

Usage in ice-cream production: Whey concentrate can be added into ice-cream mixture rather than one fourth of skimmed milk powder. Demineralised whey powder and concentrate are used in ice-cream production in England. Ice-cream is a dairy product that has specific complex physic-chemical structure and can keep this structure at -5 ^{0}C, and is obtained by being processed technologically after mixture consisting of fat, skimmed dry matter of milk, sugar, stabiliser and emulgators, sometimes aromatiser and flavouring matters (vanilla, chocolate, fruits, nuts etc.) and colouring agents. When analyzed, it is observed that ice-cream consists of the components; water, air and dry matter. First of all, obtained whey protein concentrates are subjected to pre-heating process in whey powder production. Then, applying microparticulation process, it is provided that whey proteins are denaturated and become whey powder cooled rapidly. It is very significant that diameter size of obtained whey powder particles is (1μ) and to be one sample. Indeed, the fact that their small diameters and sizes are same as fat particles does not lead to a structural problem called raggedness or roughness in obtained final product. On the contrary, they provide to develop structural properties of product and the product to gain uniformity and viscosity. They provide advantage on nutritional value as much as development of sensory properties. They affect not only ice-cream but also many traditional fatty food products in terms

of nutrition positively. They increase characteristic feature expected from milk in products that whey powder is used and provide milk flavour to get perceived much more especially in ice-cream. Due to structural property of whey powder, they assist expected flavour to progress within formation of fatty and soft structure. They assist ventilation due to their property of very proper water binding. At the same time, they prevent whey from spreading very properly, fat and whey layers from separating and whey from becoming in free condition. Whey proteins have two remarkable functions in ice-cream. First one is to assist foam structure to be stable providing air-water interaction; and second function is to create fattiness effect covering surface of ice crystals forming in ice-cream and prevent formation of ice crystals and thus, prevent ice sense forming in mouth.

Whey powder is added in order to enhance skimmed milk dry matter onto desired level if milk is used directly since whey powder is cheap, and whey powder can be added partially if skimmed milk powder is used. It is recommended that it is used in 1-2% rate of ice-cream mixture in ice-cream making or in 20% rate of skimmed milk dry matter. When this rate exceeds 2.5% rate of ice-cream mixture or 25% rate of skimmed milk dry matter, it leads to structural and flavour problems and defects in ice-cream. Lactose in structure of whey powder is demolished by hydrolisation and then glucose and galactose form and they are used as flavouring agent in ice-cream.

Usage in Bakery Products

***Usage in Bread Making*:** Usage of whey in bread making can provide to remain bread fresh for longer time, bread to have more volume, bread pore structure to get improved and

desired colour to form on bread crust. Whey powder derivatives perform more positive functional properties particularly in dried bakery products by spraying. Partially demineralised whey powder derivatives are preferred in bakery products.

Usage of additives in bread making has a critical place in nutrition with its property to be staple food, and for the sector in extreme competition environment to provide quality and variety with its high production volume. A significant group in bread additives consists of milk and dairy products. Milk and dairy products are used widely in order to develop nutritional (especially in enrichment in lysine amino acid) and qualitative properties of bakery products in various forms (whole-fat or semi-skimmed milk powder, whey protein concentrate etc.). Dry matter base has indicated that pasteurized buttermilk water in 1.0% rate and whey and strained yoghurt water in 2.0% rate can be added into bread formulation. Additive in 1% rate corresponds to 1/3 rate of water in which additive is used and additive in 2% rate corresponds to almost 1/2 rate on the basis of dry matter. Thus, it has been determined that these products becoming waste can be utilized increasing nutritional value of bread, furthermore bread quality can be increased and optimum by-product is whey. In the event that mentioned products are pasteurized in liquid form and usage of them is extended, usage levels can be increased up to higher positions using additives that increase quality and it can provide more

added-value in both dairy and bread making sectors finding cheaper area of usage than powder form.

In a study, WPC powder and buttermilk water powder have been used in leavened and unleavened doughs together in different amounts and their effects on bread quality have been analyzed. It has been discovered that usage of WPC and buttermilk water powders together has developed dough properties in terms of maximum resistance value, resistance against elongation and dough stability. It has been indicated that WPC and buttermilk water powders can be used together in bread making and production, enrichment in mineral and protein and development of sensory properties.

Usage of WPC or whey powder in bread making enables special products to get produced (for example; bread making enriched in protein), nutritional value of bread to get increased, formation of bread and qualities of types of bread submitted to market to get affected positively. Usage of WPC is recommended in bread making, lactose of which is hydrolyzed or fermented and which is concentrated up to dry matter in 40-60%. Fermentation of lactose is performed by inoculation of lactobacilli in whey. Hydrolisation is also performed by β-galactosidase preparates obtained from microorganisms. In the researches, it has been determined that flavour and aroma in obtained bread has been affected positively because of the fact that amount of volatile fatty acids (propionic acid and butyric acid etc.) has increased in 100% rate in whey lactose of which has been hydrolyzed using β-galactosidase preparates. This type of whey protein concentrate whose protein amount is found high and lactose amount is found low can be used successfully in making bread maximum in 2%

rate. Whey powder can also be mixed in bread paste in 2-5% rate; however, the amount should be determined in accordance with properties of W powder being used.

In the event that pasteurised whey powder or concentrates are used in bread making in bakery products, nutritional value and quality increase and it is also enabled to utilize this by-product. However, in the event that it is used in bread making in such a way that it is obtained and in high amounts, it affects quality of bread negatively due to lactose content and mineral matters in high amounts. Microorganisms used in bread making can lose their activities due to high osmotic pressure that lactose causes. On the other hand; proteose-peptone, one of significant components of whey, has effect to soften paste and decrease bread volume. For this reason, it is more appropriate to be used in the form of W powder or concentrates. The rate must be between 1-7% if W powder is used directly. If WPC is used, recommended usage rate in bread making is almost 2%.

Usage in Meat Products

Whey proteins are used in production of meat products such as soudjouk, salami and sausage as additive maximum in 2% rate. Additives that have high protein content and cannot be meat are utilized particularly in emulsion-type meat products in order to produce products having lower-cost, more stable and more acceptable structural and nutritional properties. Nowadays, for this purpose, WPC and W powders are used in meat industry.



There are a wide range of studies related to usage of WPC in emulsion-type meat products such as frankfurter and bologna sausage. Researches mainly concentrate upon usage of powder products (such as WPC or W powders) in meat products. However, in a study made; usage possibility of whey instead of ice in production of frankfurter type sausages has been researched upon determining effect of these types of sausages on sensory, chemical and technological properties. Results have suggested that definite and clear differences do not exist in determined sensory, technological and chemical parameters. However, it has been demonstrated that emulsion stability increases prominently by addition of liquid whey into formulation. It has been discovered that an increase occurs in pH value and ash content in very low level by addition of whey. Even, it has been detected that replacement of ice with whey in 100% rate does not have any negative effect upon sensory properties of cooked sausage. In this way, it has been demonstrated that natural fresh whey can be added in frankfurter type sausages in order to produce valuable products within minimum cost and utilize residues.

Attention to low-fat meat products gradually increases every day. However, fat substitutes are used in order to give low-fat products sensory and structural properties back, particularly; flavour that fat provides to product. For this reason, it has been researched upon usage of whey powder in production of

Turkish type meatball made of beef. Whey powder in different rates (0%, 2%, 4%) has been added in meatballs formulated in different fat rates (5%, 10% and 20%). It has been determined that usage of whey powder increases fat and water binding level in meatballs and develops cooking characteristics in each fat rate. Meatballs including whey powder have been perceived as more light-coloured. However, addition of whey powder in 2% or 4% rate has caused prominent differences in sensorial properties of meatballs having low-fat content. It is recommended that whey powder is used in traditional Turkish type meatballs as filler in order to develop cooking properties.

Whey usage in human nutrition

Nowadays, there is an increasing demand for exciting new food products and new products are produced and developed using whey. Because, these products contain 360 kcal/100 g energy, protein in high amounts and remarkable minerals such as calcium, magnesium and phosphor. For this reason, these dairy residues are also used in production of food supplements, food beverages and bars with protein-enriched products. Whey are used in paediatric and geriatric nutrition, medical nutrition (enteral foods), weight protective foods, powder dietary supplements and powder sports food products due to nutritional qualities of whey. Whey can be used either by itself or also in combination with other proteins in these applications.

There has been an increasing demand on beverages providing ***high protein and low lactose*** in recent years. whey, due to rich protein content, is used to enrich protein content of food and beverages without increasing their lactose content in remarkable levels. Whey is used in humans for the purpose of nutrition within these fields:

- Desserts, bakery products, low-fat foods,
- Emulsions: soup, sauces, salad sauces etc.
- Geriatric nutrition, medical and clinical nutrition products
- Ice-creams
- Follow-up Formula, growth milk
- Low-lactose products and beverages
- Processed cheese, cream cheese and fresh cheese types
- Production of protein/nutrition bars
- Sports and nutritional beverages, beverages used instead of food,
- Standardization of protein content in cheese milk
- Yoghurt/fermented dairy products
- Weight-protective foods and beverages.

Usage in Baby Foods

Although attention on the fact that babies are breastfed and percentage of usage of breast milk have increased in recent years, artificial baby foods are also still widely used, which are produced based on cow's milk proteins. Whey proteins can be added into baby foods to a large extent. Lactalbumine and lactoglobuhn in whey provide positive effect on normal growth and development due to the fact that they include remarkable amino acids required in baby nutrition. β-lactoglobuhn is the protein having the highest rate (58%) in whey proteins and it has a remarkable role in carrying passive immunity in newborn babies and regulating phosphor metabolism in mammary gland. α-lactalbumine, the secondary protein included the most in amount among whey powders, also functions as coenzyme in

lactose biosynthesis, a remarkable energy source for newborn babies. Pure α-lactalbumine obtained from W is used in baby foods since it is similar to basic protein in breast milk in terms of structure and composition.



Beside these positive effects, it is also stated that some types of cow's milk proteins in baby food formulations can lead to allergic diseases in babies. The requirement to develop alternative formulas against this allergy for babies has emerged. Baby foods exist, which are produced from soybean protein isolates or hydrolyzed caseins. However, it is stated that hydrolyzed caseins are hard to produce and formulations including soybeans also lead to high immunological sensitivity. Furthermore, it is also stated that soybean proteins can also be as antigenic as cow's milk proteins. Effect of heat treatment applications on antigenity of cow's milk proteins is one of the topics studied intensively. It has been demonstrated that antigenities of whey proteins are reduced by heat treatment although caseins are heat stable.

Heat treatment application on whey proteins is a simple and appropriate strategy to produce hypoallergic baby food. Lactose concentration must be reduced by diafiltration just before heat treatment application in order to prevent formation of undesirable Maillard reaction products. Carbohydrates, vitamins and minerals can be added later. Mineral matter exists in 8-10% rate in W dry matter. This situation leads to problem

in usage of whey and whey powder in baby food formulations. Minerals are reduced in 90-95% rate by process made in order to make similar to mineral content of breast milk. Electrodialysis, ion exchange and nanofiltration, and combinations of these processes can be used in order to remove minerals from whey. Generally, there are not only similarities but also prominent differences between breast milk and cow's milk. It can be seen that α-lactalbumine is the protein existing in both milk when protein profile is analyzed. However, β-lactoglobuhn is a basic protein existing in whey but not existing in human milk. This protein is one of materials leading to allergy in babies and placing restriction to usage of cow's milk in preparation of baby food formulations. This protein, even in low amounts, can lead to allergic reactions in babies having high sensitivity. For this reason, hydrolyzed casein and hydrolyzed whey formulas are recommended for babies. In a study made, it has been demonstrated that feeding within partially hydrolyzed formulas of whey protein in 100% rate rather than cow's milk formula reduces risk of Atopic Dermatitis (in group of allergic diseases) in babies not fed with only breast milk, particularly babies having an allergic background in family. Other methods that can be applied related to WPC to be used in baby foods are the fact that β-lactoglobuhn is to get removed utilizing membrane separation processes such as ion exchange chromatography or UF. Also in another study that WPC is used as raw material in baby foods, β-lactoglobuhn more than 99% rate has been removed and a product, rich in α-lactalbumine protein (retrieval ratio; 86%), has been obtained.

Whey usage in sportsman nutrition

Whey proteins are used as ingredient in sports drinks due to the fact that they contain high quality protein. Researches made suggest that whey proteins provide athletes numerous benefits. Some clinical studies have indicated that whey proteins taking place in diets of sportsmen increase athletic performance directly.

Particularly; WPC 80 and WPI, within their fat and lactose content in minimum level, provide high quality protein for sportsmen. Whey amino acid profile is similar to amino acids in skeletal muscles to a large extent.

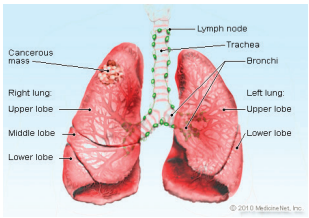
Whey protein supplements generally contain basic amino acids in higher rate than other protein resources. These basic amino acids are the ones required for protein synthesis in muscle. Whey protein supplements are also rich in branched structured amino acids. These amino acids are leucine, isoiysin and valine. These amino acids play a remarkable role in muscle metabolism for athletes. Because of the fact that these branched structured amino acids, particularly leucine, have key role in DNA translation in protein synthesis, the fact that this amino acid is provided for muscles brings a more effective recycling with itself. Cystein amino acid in structure of whey proteins assist sportsmen to keep their body weights as much as muscle development. Whey proteins have a unique value within the fact that they are digested in a more different way than other proteins. The fact that they are absorbed in body rapidly provides more amino acids to reach tissues and protein synthesis in higher rate resulted with higher protein gain.

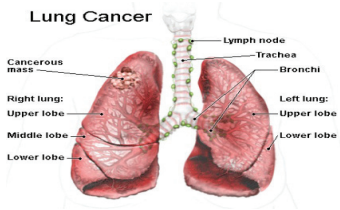
The fact that whey proteins are soluble in water and can mix with any liquid easily enables them to get used before,

during and after training. Whey proteins are one of several recommended nutritional supplements in order to develop physiological adaptation during exercise and increase athletic performance. Researches are not in sufficient level yet, which have been made upon usage of wheyproteins for optimization of sportsman health and performance. For this reason, more clinical researches are required to be completed to make more clear and definite suggestions.

Whey usage in medical and cosmetic products usage in medicine

Whey proteins are widely used as muscle forming supplement with high protein quality and high branched chained amino acids. Additionally, whey as a functional food, gains importance in application for ***cancer, hepatitis B, HIV, cardiovascular diseases, osteoporosis*** and even ***chronic stress diseases and disorders.***





Whey has a protein structure including beta-lactoglobuhn, alfa-lactalbumine, bovine serum albumin and glycomacropeptides. For this reason, its protein includes a full spectrum of branched chained amino acids (leucine, isoiysin and valine). So, it has a remarkable role in protein synthesis. Whey is rich in cystine and methionine; amino acids including sulphur.

These amino acids increase immunity function through transformation in glutathione. Whey does not include phenylalanine, tryptophane and thyrosine; aromatic amino acids, although it is a resource for branched chained amino acids. This situation makes them a protein that has vital importance in phenylketonuria individuals.

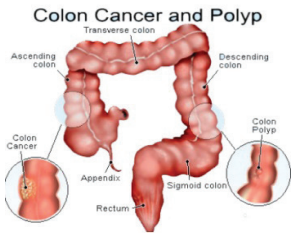
Lactoferrin is a glycoprotein that does not have haem group and binds iron, and has antioxidant effect. Lactoferrin also stimulates immune reactions including natural killer cells (NK), neutrophilles and macrophage cytotoxicity. It even shows an anti-inflammatory effect adjusting level of lactoferrin tumor necrosis factor (TNF) and interculin 6 (IL-6).

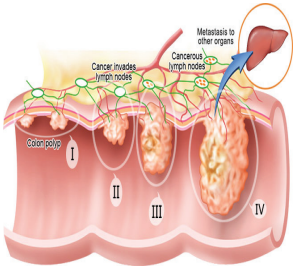
Immunoglobulins (IgG) existing in W protein in 10-15% rate are based on bovine milk. These bovine IgGs are significant for IgG, IgA and IgM production in humans. For this reason, bovine IgGs has a potential in formation of immune response in humans.

Lactoperoxidase is an enzyme available in whey. This enzyme has an extended antibacterial effect. Its effect is connected with preventing formation of hydrogen peroxide and catalyzing of thioperoxidation. The enzyme is so resistant that it can remain inactive during pasteurization. Researchers have performed tests on mice such as biological and physiological changes, measurement of muscle glycogen level, changes in performance depending upon whey protein based food consumption before they analyze effects of whey proteins and amino acids on human health.

They have determined their effects for various diseases on humans. It is asserted that whey proteins have more effects on cancer in comparison with casein. Tests and researches made

on animals have indicated that whey prevents tumour formation and as a result, cancer risk decreases. ***It has been put forward in test made on mice that whey proteins are more effective in preventing colon cancer in comparison with other proteins such as meat and soybean proteins. It has been stated that diets supported within Lactoferrin or β-lactoglobuhn increase protective effect against development of tumor premises in intestine wall.***





Antioxidant and detoxification effect of whey are related to **glutation** synthesis. It joins in formation of glutation in combination with cystine, glycine and glutamate including antioxidant thiol group. Glutation is the main endogenous antioxidant produced by cells and provides RNA, DNA and proteins to get protected. Glutation detoxifies endogenous and exogenous toxins including toxic metals, petrol distillates, lipid peroxidise, bilirubin and prostaglandins. Whey proteins are unique proteins increasing glutation production depending upon the fact that cystein concentration is in high level.

There are researches and studies related to the fact that lactoferrin and lactoferricin in whey also exhibits antioxidant feature. Besides, it is stated that bioactive peptides originating from whey protein inhibit angiotensin converting enzyme (ADE) and they exhibit protective effect against hypertension.

There are evidences related to the fact that whey supports bone development and protection and prevents osteoporosis formation due to lactoferrin and lactoperoxidase, and obesity formation by preventing body structure with weight control. It is reported that lactoferrin consumed within foods is effective against pathogens such as bacteria and virus. For example; it has been demonstrated and exhibited that lactoferrin has protective effect against *Haemophilus influenza* virus leading to otitis in children. Additionally, it has also been discovered that lactoferrin has protective effects against various viruses containing cytomegalovirus (CMV), influenza type A and B, rotavirus, Herpes simplex type 1 and type 2 and hepatitis C. It has also been detected that plasma glutation concentration increases in remarkable levels in HIV patients consuming whey supplements. There are also researches and studies indicating that whey proteins reduce plasma and liver cholesterol levels.

Nowadays, whey proteins and amino acid supplements provide superiority in terms of side effects to which medical drugs lead on humans. For this reason, more physiological applications should be performed determining effects of whey proteins and bioactive compounds and results should be defined and explained.

Usage in Cosmetic Industry

Nowadays, technological developments in cosmetic industry form within the framework of quality of products, usage of natural resources in production and environmental concerns. Hydrocolloids, as much as proteins, are used in production of products having functional properties and biological activity.



Whey is a significant resource taking place among natural cosmetic ingredients due to valuable compounds it contains, particularly proteins. Related to this matter; properties of whey proteins; water binding, foam generation, emulgator and gelling come into prominence. Hydrolyzed whey proteins take part among functional ingredients defined as safe in cosmetics. Hydrolyzed whey proteins obtained as a result of partially hydrolysis of whey proteins by acid, enzyme or other methods have potential to be used as skin moisturizer in cosmetics. It has been determined that low molecular weight compounds in whey proteins have very similar characteristics as natural moisturizer factors do in human skin.

Low molecular weight fraction of whey minerals applicable for cosmetics come out as a by-product during production of whey concentrate or whey isolate from whey. Abilities of these agents such as solubility in water, water binding and spreading in cells rapidly resemble hyaluronic acid used in cosmetic industry. For this reason, these agents obtained from whey are used in cosmetic products and soaps and lotions produced for babies. Besides, it has also been demonstrated by clinical experiments that these cosmetic products do good for dermatitis, a skin disease.

The results obtained from a research made on usage of whey in shampoos have demonstrated that whey can be used

in this product successfully. It has also been determined in the same research that usage of whey in shampoo has made a positive effect on foaming ability. Surface-active agents such as alkyl ether sulphates are detergents used primarily in shampoo formulations. Despite the fact that foaming and washing properties of these agents are very good, they can lead to excessive oil loss in hair and irritate eye and skin. It has been intended that this problem can be solved by usage of a natural product in shampoos such as whey. Besides, whey proteins and minerals functions as an effective thickener for shampoo and increase viscosity of product. Usage of whey as a cosmetic product is a subject which is obliged to get studied and researched on more intensively due to the fact that it turns into another application in waste utilization and in this way, provides a natural raw material to get used in cosmetic products.

Proteins, vitamins and minerals included in whey structure are assimilated rapidly in body when they are taken internally. Whey supplements both feed skin and strengthen hair. Whey renews and enriches skin and hair cells that are rich tissues in proteins. Whey can also be used directly for this purpose. However, disadvantage it can constitute in flavour can be removed by mixing it with fruit juices.

Whey is a perfect hair care product. Whey feeds, strengthens and softens hair. Whey also feeds head skin since it is lightly acid. Whey can be used within shampoos if hair is not dirty and oily. It is recommended that hair is to get cleaned with shampoo at first and then rinsed and cleaned within whey if hair is clean.

Whey can be used as all-in-one as soft cleaner, tonic and moisturizer on skin. There are several commercial skin products produced for this purpose and including whey. Whey is also used for acnes. Whey increases skin brightness, too. For this purpose, whey baths are also recommended and they are recommended to get used in such a way that 1-2 bowls of whey are mixed into water and skin is waited to absorb it for 10-20 minutes. Light acid structure of whey supports pH level of skin to get restored and skin cells to get renewed. Furthermore, it is stated that cold whey bags can be used for bleary eye and under-eye.

Usage in Animal Feeding

In animal feeding, whey is used to make animals drink it directly or get added into roughage. The best storage way of W in liquid form is to keep in storage tanks. pH levels should be reduced to 3-4 in order to prevent sweet or acidic whey from getting spoilt. Any dairy cow can drink 35-40 litres (maximum 50-70 kg) of whey per day, dry matter of which is low.

This consumption reduces consumption of low cellulosic roughage. The fact that whey in great amounts is given hungry dairy cattles in a short time leads to metabolic disorders such as acidosis and tympany and even death can occur. Water consumption can be restricted temporarily (5-10 hours) in order to make dairy cattles get accustomed to whey consumption. whey can be added into rations of feeder cattle too. In the researches conducted mostly with ruminants, digestibility of dry matter in feed increases prominently in the event that fodder is given animals softened by using whey instead of water. However usage in liquid form is very limited due to high lactose and mineral matter content. In cattles feeds of which whey has been added into in 5% rate, it is stated that utilization rates of crude protein and phosphor, as much as dry matter in feed, have increased. More than half of produced whey is used as additive for animal feeds in western countries. It has been detected that there is increase of oil in 0.05% rate, protein in 0.13% rate, casein in 0.09% rate in milk of cows fed with whey, and it has also been observed that milk obtained from these animals has fermented and coagulated in a short time when they are used in cheese making.

Whey has been used in feeding of young animals, in production of milk replacer for particularly; calves, lambs and kids for a long time. Whey products, as skimmed milk powder replacer, have usage advantages in these animals within reasons to avoid usage of antibiotics for digestion and health problems and the fact that there is an increasing attention to natural ingredients to develop performance and health.

Benefits provided in animal husbandry by usage of whey are the ones in the following:

• Whey is a natural agent obtained from fresh milk.

• Whey products include high-quality protein, lactose, bioactive compounds, minerals and vitamins.

• Whey has a perfect solubility.

• Whey does not include anti-nutritional agents.

• Whey is very delicious and easy to digest.

• Whey increases feed consumption rapidly in calves, lambs and kids just after delectation.

• Whey heals and improves animal performance and digestive system health.

Remarkable part of whey that comes out in western countries is utilized in animal feeds as additive.

Condensate whey fermented and in which ammonia is added can be used as liquid protein resource in feeding of sheep and goat. Usage of dried whey in low amounts or whey lactose of which is removed partially in rations of other animals apart from sheep and goat increases weight gain, yield in nutrition, protein and fat digestion and mineral absorption. The fact that whey is added into silages produced from grass and legumes increases silage quality and digestibility. Besides, ammonium nitrogen concentration in silage can be reduced when whey is added into corn silages processed with urea. It is stated that the fact that calves are fed with milk replacer including whey dried up to 89% is convenient for their growth rates.

Usage in milk replacers

Whey products are used for calves, lambs and kids because of the fact that they have flavour in high level and good digestibility; so, they increase appetite, feed consumption and improve health and performance. Processed carefully, whey still contains bioactive agents in a certain amount, which originate from milk. Production and sale of milk replacers generalize all over the world rapidly, which takes a significant place in calf feeding.

Prices of milk replacers have come under question economically due to increase in prices of whey in recent years just after whey has started to be used intensively in milk replacers, which has many advantages for calves. The fact that whey is utilized particularly in production of milk replacer has both contributed into dairy industry to a great extent and become a solution for environmental pollution problem. Milk replacers consist of dairy products such as high-quality whey protein concentrate, dried whey, delactosed whey and dried

skimmed milk and casein and herbal protein supplements, starch, dextrines, fat and oil. Vitamins, minerals, emulsifiers and antioxidants are also added into these feeds. Digestive physiology of calf must be taken into consideration in selection of components to be used in milk replacers. In another words, carbohydrate, protein and fats must be included in compound of milk replacers. By-products of dairy industry should be preferred in milk replacers due to the fact that they are easy to digest and quality.

Young animals are put into particular shelters or growth divisions being separated from their mothers just after birth. Animals have problems in this environment about digestive system health because of digestive system problems (diarrhoea), stress, viral cross contaminations. Usage of whey products provides great support in healing and improving health situations of these animals. Skimmed milk is the basic protein resource in milk replacers for calves in postpartum period. The fact that whey proteins are used in milk replacers instead of skimmed milk powder reduces milk replacer costs, too. For this reason, whey products are basic protein resource in milk replacers. Researches made on usage of whey products in milk replacers indicate that whey products have effects as equal as skimmed milk. Even results emerge, which demonstrate that whey products provide more positive results than skimmed milk. Because; whey and concentrates include lactalbumine protein on the other hand skimmed milk casein-lactalbumine protein. Researches and studies made for analyzing protein efficiency rate indicate that whey proteins have higher digestibility level.

Milk replacers generally contain crude protein in 18-28% rate. Crude protein contents of milk replacers used in feeding of calves are different however reflection of increasing crude protein content to growth is related to energy consumption. In other words, the fact that more energy consumption increases, more protein consumption increases affects growth positively. For this reason, the fact that a standard protein value is given to meet needs of calves can lead to wrong results.

Amino acid profile of whey proteins is on perfect values for growth and development of calf. Whey proteins are the best protein resources for calves younger than 21 days old due to the fact that their digestibility rates are high, amino acid balances are appropriate and they do not contain anti-nutritional factors. Many feeding operations made on calves indicate that milk replacers based on high-quality whey can be used efficiently even when they are consumed in high amounts by calves. Whey consists of water, lactose, minerals and other proteins (immunoglobulins). It is started to get discussed in milk replacer industry whether it coagulates or not in abomasums when passed from skimmed milk powder to whey. It is known that only casein forms coagulum in abomasum. The fact that whey proteins do not form coagulum in abomasum does not mean that digestion of these proteins is affected negatively. Because whey protein is digested naturally passing to small intestines of animal without getting affected by abomasal proteolytic enzymes in 10 minutes just after calf is made whey protein drunk. It is the most important criterion to consider that milk replacers including milk protein completely based on whey protein have high digestibility and they provide calves to grow and develop. In researches and studies made, any differences have not been detected in daily live weight

increase, feed utilization rate, diarrhoea incidence or other diseases in milk replacer feeds prepared based on skimmed milk powder or whey.

Usage in Feed Supplements

The fact that antibiotics are restricted to use in animal feeding, organic products are preferred by consumers much more direct scientists to make researches related to usage of alternative feed supplements.

Some of alternative feed supplements are probiotics, prebiotics, organic acids, immune system developers, enzymes and vegetable oils. It is tried to get proved the effects of these alternative feed supplements with many researches and studies, which may occur on values of young animals such as health, performance, product quality and immune system. This situation makes studies and researches important, which is about making alternative feed supplements more useful. Usage of whey in microencapsulation technology has been put forward with researches made in order to prevent products in digestive system produced in different circumstances. Microencapsulation technology has been used in many fields for long years. It has started to be used in food industry in recent years. The fact that this technique is used in food industry provides new opportunities in development of new

products having properties such as having high functional properties, longer shelf life, being nutritious. Technique and covering material of which microcapsules are made affect the function, which are obtained with microencapsulation technology. For this reason, it must be known very well about properties of material that is to get covered with agent to be used as covering material. Whey proteins have properties of good emulsification, gelling and film formation and they present desired functional properties as also covering material in microencapsulation technology. Physico-chemical properties of whey proteins provide perfect advantages in controlled release of agents encapsulated from microcapsules and formation of new microcapsules in food applications. Purpose of microencapsulation of probiotic microorganisms is to protect these sensitive cells reducing their connections with environment. Microcapsules formed of aqueous solutions of milk and whey proteins in high concentration form a gel net and microcapsules formed in suitable diameter make usage of probiotics as feed supplements more effective.

Whey protein isolates used as covering material in encapsulation of lipids provide an effective protection against oxidation during storage. In an observation made, it has been stated that orange oil encapsulated using whey protein isolates is more resistant against oxidation and they are effective in microencapsulation of volatile compounds within spray drying method. Whey is used in feed supplement sector, production of silage additive or silage making applied directly. It is applicable that whey is to get added into feeds rich in protein in 2-3% rate, which contains dry matter in 7% rate and lactose in 4.4% rate. Whey dried or thickened for this operation should be added after it gets diluted up to a certain density.

Lactose disaccharide in whey gets fermented into lactic acid by some lactic acid bacteria. It is known that yeasts have been used as animal feed in agriculture field for many years. Yeast rate added into feed is too low in these applications aiming to benefit from only B vitamin they include. However, operations on usage of yeasts as protein resource have increased and intensified after they have been detected to include protein in high amounts. It has been proved within experiments that yeasts including protein more than 50% in compound in general are rich protein resources for not only animals but also humans.

Whey is one of the agents used as substrate in production of yeasts. Reproductive conditions of 9 separate yeasts in whey have been observed in an observation. The fact that these yeasts can use whey is connected to the fact that they include ß-galactosidase enzyme that can digest lactose. Ultimately, the best reproducing yeasts are Brettanomyces anomalus and K. Fragilis. It has been tried to grow yeasts, Kluyveromyces lactis and C. Tropicalis, in whey in observations and operations. Any remarkable difference has not been observed when reproductive amount in mixed culture is compared with the one in single culture. It has also been researched about usage of whey as medium and it has been demonstrated that it can be utilized as agar.

Whey Usage in Soil and Agricultural Practices

Usage in Soil Practices

Usage of whey can affect physical and chemical structure of soil due to the fact that it includes salt and suspended solid matter in high rate. First of all, soil acts as a filter and solid matters remain on soil surface. Then the fact that these

matters accumulate can cause gas circulation and transmission to decrease. Notwithstanding, some researchers put forward that a major part of soil consists of sugar and proteins open to biodegradation. NaC1 content reduces usability of water for plants. Besides, increase in transmission can damage soil structure since it reduces aeration level and penetration rate of water. For these reasons, whey must be diluted with clean, fresh water in 1:20 rate in order to reach acceptable irrigation water quality. Some measurements must be taken in whey application in soils. First of them is the fact that location of irrigation water resources must be designed to prevent underground waters from being polluted. Some researches and operations performed related to improvement of basic soils sodium rate of which is more than 15% have indicated that this application reduces soil sodium adsorption rate, Na percentage and Ph, and increases soil flocculation. Additionally, an increase can also be detected in crop production. However, whey application in too much rate can lead to decrease in yield. It has been demonstrated that whey has fertilization property on acid soils in order to make too rainy regions available. It is stated that usage of whey can develop structure of non-alkaline or worn (suffered from erosion) soil by increasing aggregate stability. Organic materials in whey are decayed in CO_2, organic acid and nitrate biologically. Increase in calcium solubility can assist aggregates consisting of other organic compounds to be stable. However, some researches and operations indicate that this application damages wheat because of rapid decrease in redox potential (- 350 mV) and rapid consumption of O_2 in soil.

Usage in Agriculture

Whey is a by-product that has usage potential in some agricultural practises. Researches made have indicated that whey has inhibitor effect against some plant viruses. Researchers have demonstrated that operation of spraying whey on barleys' surfaces prevent a kind of virus from passing through plant surface and virus from spreading all over field. They have discovered that this antiviral effect is related to whey proteins. It has been detected in also another conducted research that operation of spraying whey on tomato leaves during 6 days period reduces activity of tomato mosaic virus prominently. Besides, it has been demonstrated that whey is effective against some kind of viruses that can grow in cucumber and tobacco.

There are models related to usage of whey as insecticide in agricultural practices. There are several researches and observations on usage of whey for control of thripidae eating saplings. It is reported that whey has usage potential as bait against thripidae in citrus fruits.

Phloxine B, photoactive paint, and whey are combined for commercial control of this insect. Furthermore, several researches and operations are included on usage of whey in also control of insects in flower bulbs. Whey can be used to make

animals drink directly or add into feeds in animal nutrition. It has been detected in observations conducted mostly on ruminants that digestibility of dry matter components in feed increases in the event that dry matter is given animals softened by whey instead of water. Furthermore, it is determined that an increase occurs also in rate of utilization from protein and phosphor when Whey is added into feed in 5% rate.

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8. ENTREPRENEURSHIP, NEW BUSINESS OPPORTUNITIES AND MARKETING STRATEGIES FOR WHEY PRODUCTS

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Whey is an important economic resource. In case of not using this resource, it will be able to occur both environmental pollution and economic losses. Whey, the liquid residue of cheese, casein and yoghurt production, is one of the biggest reservoirs of food protein available today. World whey output at approximately 180 million tonnes in 2013 contains some 1.5 million tonnes of increasingly high-value protein and 8.6 million tonnes of lactose, a very important source of carbohydrate for the world. The latest research shows that whey protein is arguably the most nutritionally valuable protein available; little wonder that nutritional markets such as sports, clinical and infant nutrition are driving an unprecedented investment level in dairy production. Packed full of 'natural goodies' such as high-gelling b-lactoglobulin, mother's milk equivalent protein a-lactalbumin, lactoferrin, and immunoglobulin and as a precursor to the probiotic galactooligosaccharides (GOS), whey is proving to be one of the most exciting nutrient sources available today. Whey as a by-product from the manufacture of hard, semi-hard or soft cheese and rennet casein is known as sweet whey. Whey products is an important market for entrepreneurs

and this market is increasingly growing. Emtrepreneurs can produse by developing new whey products or they can produce existing products, depending on customer demand. Entrepreneurs can want to take advantage of opportunities of whey products. But there are some rules to enter the whey products market. These rules also refer to the entrepreneurship and principles of the entrepreneurship. Entrepreneurship is a value creation processes is an important role in economic development, motivating and ancouraging innovations. In an OECD Economic Survey in 1997, it was defined as "the dynamic process of identifying economic opportunities and acting upon them by developing, producing and selling goods and services.

Principles of the Enrepreurship - Choosing A Product and A Market

A prospective entrepreneur needs to come up with a good idea. This will serve as the foundation of the new venture. Sometimes an entrepreneur sees a market need and has an idea for a product or service to fill it. Other times an entrepreneur gets an idea for a product or service and tries to find a market for it. There are many ways to look for ideas. Read a lot, talk to people, and consider questions such as: What limitations exist in current whey products and services? What would you like whey products are not available? Are there other uses for new technology? What are innovative ways to use or to provide existing whey products? Is society changing? What groups have unfulfilled whey products needs? What about people's perceptions? It can be followed the following strategies to enter the whey products market:

• **An existing whey good or service for an existing whey market:** This is a difficult approach for a start-up operation. It means winning over consumers through merchandising appeal, advertising, etc. Entry costs are high, and profit is uncertain. However, whey products market is a growing market. it can be enter to this market so.

• **A new good or service for a new market**: This is the riskiest strategy for a new firm because both the product and the market are unknown. It requires the most research and planning.

• **A new good or service for an existing market**: This can be a moderate strategy for a new firm because the market are known. It requires the most research and planning for new goods.

• **An existing good or service for a new market**: The new market could be a different country, region, or market niche. Entrepreneurs who provide goods/services at customers' homes or offices, or who sell them on the Internet, are also targeting a new market – people who don't like shopping or are too busy to do so. The last two categories have moderate risk, but product and market research can reduce it. They also offer opportunities for utilizing effective start-up strategies– innovation, differentiation, and market specification

Entry Strategies for New Ventures

It is easy to be captivated by the promise of entrepreneurship and the lure of becoming one's own boss. It can be difficult, however, for a prospective entrepreneur to determine what whey product or service to provide. Many factors need to be considered, including: an idea's market potential, the competition, financial resources, and one's skills and interests.

Then it is important to ask: Why would a consumer choose to buy whey goods or services from this new firm? One important factor is the uniqueness of the idea. By making a venture stand out from its competitors, uniqueness can help facilitate the entry of a new whey product or service into the whey market. It is best to avoid an entry strategy based on low cost alone. New ventures tend to be small. Large firms usually have the advantage of lowering costs by producing large quantities. Successful entrepreneurs often distinguish their ventures through differentiation, niche specification, and innovation.

• **Differentiation** is an attempt to separate the new company's whey product or service from that of its competitors. When differentiation is successful, the new whey product or service is relatively less sensitive to price fluctuations because customers value the quality that makes the product unique. A whey product can be functionally similar to its competitors' whey product but have features that improve its operation.

• **Niche specification** is an attempt to provide a product or service that fulfills the needs of a specific subset of consumers. By focusing on a fairly narrow market sector, a new venture may satisfy customer needs better than larger competitors can. Changes in population characteristics may create opportunities to serve niche markets.

• **Innovation** is perhaps the defining characteristic of entrepreneurship. There are two main types of product innovation. Pioneering or radical innovation embodies a technological breakthrough or new-to-the-world product. Incremental innovations are modifications of existing products. But innovation occurs in all aspects of businesses, from manufacturing processes to pricing policy. Entrepreneurs

in less-developed countries often innovate by imitating and adapting products created in developed countries. Drucker called this process "creative imitation." Creative imitation takes place whenever the imitators understand how an innovation can be applied, used, or sold in their particular market better than the original creators do. Innovation, differentiation, and/or market specification are effective strategies to help a new venture to attract customers and start making sales.

Marketing

Marketing is often defined as all the activities involved in the transfer of goods from the producer to the consumer, including advertising, shipping, storing, and selling. For a new business, however, marketing means selling. Without paying customers to buy the goods or services, all the entrepreneur's plans and strategies will undoubtedly fail. How does a new business get orders? Before launching the business, the entrepreneur should research the target market and analyze competitive products. Most business sectors have specific marketing strategies that work best for them and have already been put into practice. For example, an entrepreneur can also develop a file of potential customers by collecting names or mailing lists from local sports centers, schools, and community groups or other organizations. This file can be used later for direct mailings – even for invitations to the opening of the new business.

After the new firm is launched, its owners need to get information about their product or service to as many potential customers as possible–efficiently, effectively, and within the constraints of a budget. The most effective salesperson in a new venture is often the head of the business. People will

almost always take a call from the "president" of a firm. This is the person with the vision, the one who knows the advantages of the new venture, and who can make quick decisions. Many famous entrepreneurs have been gifted at selling their products. Direct sales conducted by mail order or on the Internet are less expensive options that can be equally successful. External channels also can be used. Intermediaries, such as agents or distributors, can be hired to market a product or service. Such individuals must be treated fairly and paid promptly. Some analysts advise treating external representatives like insiders and offering them generous bonuses so that the product or service stands out among the many they represent. Advertising and promotion are essential marketing tools. Newspaper, magazine, television, and radio advertisements are effective for reaching large numbers of consumers. A less expensive option is printing fliers, which can be mailed to potential customers, handed out door to door, or displayed in businesses that permit it. New companies can also compose new product releases, which trade magazines usually publish without charge. It is also useful to be listed on Internet search engines such as Google or Yahoo, which are used by consumers for locating local businesses. These often link to a company's Web site, thereby communicating more information. Publicity is also an extremely valuable way to promote a new product or service.

New firms should send press releases to media outlets. A local newspaper might publish a feature about the startup. A TV or radio station might interview its owners. This can be very effective in generating sales, and it's free!

Creating a business plan

A comprehensive business plan is crucial for a start-up business. It defines the entrepreneur's vision and serves as the firm's resume. There are many reasons for writing a business plan:

• To convince oneself that the new venture is worthwhile before making a significant financial and personal commitment.

• To assist management in goal-setting and long-range planning.

• To attract investors and get financing.

• To explain the business to other companies with which it would be useful to create an alliance or contract.

• To attract employees. A business plan can help an entrepreneur to allocate resources appropriately, handle unexpected problems, and make good business decisions. A well-organized plan is an essential part of any loan application. It should specify how the business would repay any borrowed money. The entrepreneur also should take into account all startup expenses and potential risks so as not to appear naive. A business plan is primarily used for raising capital. the primary purpose of a business plan is to help entrepreneurs gain a deeper understanding of the opportunity they envision. The business plan process helps the entrepreneur shape her original vision into a better opportunity by raising critical questions, researching answers for those questions, and then answering them. Some entrepreneurs create two plans: a planning document for internal use and a marketing document for attracting outside investment. In this situation, the information in each plan is essentially the same, but the emphasis is somewhat different. The company description highlights the

entrepreneur's dream, strategy, and goals. The product/service section should stress the characteristics and benefits of the new venture. The financial components of a new venture's business plan typically include three projections: a balance sheet, an income statement, and a cash-flow analysis. These require detailed estimates of expenses and sales.

Expenses are relatively easy to estimate. Sales projections are usually based on market research, and often utilize sales data for similar whey products and services produced by competitors. Writing a business plan may seem overwhelming. However, there are ways to make the process more manageable. First, there are many computer software packages for producing a standard business plan. Numerous books on entrepreneurship have detailed instructions, and many universities sponsor programs for new businesses.

The entrepreneur's need for capital

New businesses rarely show a profit in the early months of operation. Generating sales takes time, and receipts are not usually sufficient to offset start-up costs and monthly expenses. Therefore, entrepreneurs need to estimate how much money they need and then raise that amount to transform their dream into a reality. It doesn't necessarily take a lot of cash to create a successful business. There are many ways to reduce expenses: for instance, by initially working out of one's home rather than leasing an office or leasing office equipment rather than buying it. However, all entrepreneurs need to estimate how much cash they need to cover expenses until the business begins to make a profit. For this task, the best financial tools are the income statement and cash flow statement. Cash flow refers to the amount of money actually available to make purchases and

pay current bills and obligations. It is the difference between cash receipts (money taken in) and cash disbursements (money spent) over a specific time period. It is important to attach notes to these forecasts to explain any unusual expenses or assumptions used in the calculations.

• An income statement sets out all of the entrepreneur's projected revenues and expenses (including depreciation and mortgages) to determine a venture's profits per month and year. Depreciation is a method to account for assets whose value is considered to decrease over time.

• A cash flow statement estimates anticipated cash sales as well as anticipated cash payments of bills. This estimate can be done on a weekly, monthly, or quarterly basis, but experts recommend that it be done at least once every month for the first year or two of a new business. This forecast is used to project the money required to finance the operation annually. The monthly net cash flow shows how much an entrepreneur's cash receipts exceed or fall short of monthly cash expenditures. For most of the first year, the monthly expenditures are likely to exceed the receipts. In many cases, goods are shipped out before payment is received.

• Meanwhile, the entrepreneur still has to pay his bills. Therefore, the cumulative cash flow, which adds each month's total to that of previous months, will result in a growing negative amount. A critical point for a new business occurs when monthly sales receipts are enough to cover monthly expenses. At this point, the negative cumulative cash flow will begin to decrease and move toward a positive one. The cumulative cash flow amount reached just before it reverses direction indicates approximately how much capital the

new business will need. Financial projections are inevitably somewhat inaccurate simply because every contingency cannot be predicted. For this reason, experts recommend that entrepreneurs add at least 20 percent to the financial needs calculated in the cash flow statement to create a safety net for unforeseen events. With these estimates, the entrepreneur can seek funding and concentrate more clearly on launching the new business.

Sources of financing

Many entrepreneurs struggle to find the capital to start a new business. There are many sources to consider, so it is important for an entrepreneur to fully explore all financing options. He also should apply for funds from a wide variety of sources.

• **Personal savings:** Experts agree that the best source of capital for any new business is the entrepreneur's own money. It is easy to use, quick to access, has no payback terms, and requires no transfer of equity (ownership). Also, it demonstrates to potential investors that the entrepreneur is willing to risk his own funds and will persevere during hard times.

• **Friends and family:** These people believe in the entrepreneur, and they are the second easiest source of funds to access. They do not usually require the paperwork that other lenders require. However, these funds should be documented and treated like loans. Neither part ownership nor a decision-making position should be given to these lenders, unless they have expertise to provide. The main disadvantage of these funds is that, if the business fails and money goes lost, a valuable relationship may be jeopardized.

• **Credit cards:** The entrepreneur's personal credit cards are an easy source of funds to access, especially for acquiring business equipment such as photocopiers, personal computers, and printers. These items can usually be obtained with little or no money paid up front and with small monthly payments. The main disadvantage is the high rate of interest charged on credit card balances that are not paid off in full each month.

• **Banks:** Banks are very conservative lenders. Many prospective business owners are disappointed to learn that banks do not make loans to start-up businesses unless there are outside assets to pledge against borrowing. Many entrepreneurs simply do not have enough assets to get a secured loan from a lending institution. However, if an entrepreneur has money in a bank savings account, she can usually borrow against that money. If an entrepreneur has good credit, it is also relatively easy to get a personal loan from a bank. These loans tend to be short-term and not as large as business loans.

• **Venture investors:** This is a major source of funding for start-ups that have a strong potential for growth. However, venture investors insist on retaining part ownership in new businesses that they fund. Formal institutional venture funds are usually limited partnerships in which passive limited partners, such as retirement funds, supply most of the money. These funds have large amounts of money to invest. Corporate venture funds are large corporations with funds for investing in new ventures. These often provide technical and management expertise in addition to large monetary investments. However, these funds are slow to access compared to other sources of funds. Also, they often seek to gain control of new businesses.

• **Angel investors:** Angel investors tend to be successful entrepreneurs who have capital that they are willing to risk. They often insist on being active advisers to businesses they support. Angel funds are quicker to access than corporate venture funds, and they are more likely to be invested in a start-up operation. But they may make smaller individual investments and have fewer contacts in the banking community.

• **Government programs:** Many national and regional governments offer programs to encourage small-and medium-sized businesses.

Choose the right team

When assembling your team, it is imperative to gather a team with the same mindset and attitude towards achieving a common goal. You must not involve family or close friends especially those without any knowledge or expertise they can add to your startup. Your team must have the same drive, tenacity, perseverance and an underlying belief in themselves and the value they can add to the success of the business. Your team must be motivated and dedicated.

The Entrepreneur and the Internet

The Internet a vast computer network linking smaller computer networks has revolutionized commerce by bringing together people from all over the globe. Many of its features can be used to shape a new business. Communications: An entrepreneur must communicate with many people-suppliers, distributors, and customers, for example. A quick and relatively inexpensive way to send letters, reports, photographs, etc. to other Internet users is with electronic mail or "e-mail." Email can be used even for marketing. Various forms of computer

software are available to protect documents from unauthorized access or alteration so that they can be securely shared and easily authenticated.

• **Research:** Starting a business takes lots of research. An entrepreneur can find information on almost any subject very rapidly by using the Internet's World Wide Web. (The Web is a collection of text and multimedia documents linked to create a huge electronic library.) Many government agencies, universities, organizations, and businesses provide information on the Internet, usually at no cost. The easiest way to find information on the Web is by using a search engine-a data retrieval system. The user types key words for a subject on the computer, clicks the enter button, and receives a list of materials — often within seconds. The items are linked electronically to the actual documents so that Internet users can read them on their computer screens.

• **Promotion:** Web sites, pages of print and visual information that are linked together electronically, offer an opportunity for entrepreneurs to introduce a new business and its products and/or services to a huge audience. In general, Web sites can be created and updated more quickly and inexpensively than printed promotional materials. Moreover, they run continuously! To create a Web site for her business, the entrepreneur can hire a firm to create one or purchase computer software to create it on her own. Many universities offer courses that teach how to build a Web site, also. A Web site needs a name and an address.

On the Internet, the two are usually the same. Web site names and addresses must be registered. The address of the online business is expressed as a Uniform Resource Locator (URL). It usually ends in dot com (.com), which indicates a

"commercial" site. Dot net (.net), an alternate ending; is often used when a specific Web site name ending in .com has already been registered. Good business Web site names are easy to remember and evoke the firm and its products or services. The entrepreneur also needs a piece of property in cyberspace, where her Web site will reside. Web site promotion is critical. A Web site address can be put on business cards, stationery, brochures — anything having to do with the new firm. Or, an entrepreneur can pay to place a colorful advertisement on non-competitive Web sites, such as ones for complementary products. Advertising banners usually link back to the advertised firm's Web site. Entrepreneurs also can provide information about their Web sites to well-known Internet search engines. Online shoppers, for instance, often use search engines to find businesses that provide specific products and services.

Safe Use: Just as shopkeepers lock their storefronts, entrepreneurs who use the Internet need to take steps to keep their computer systems safe from the potential hazards of security breaches and viruses. One of the most effective steps is installing security software. Another is setting up an Internet firewall to screen and block undesired traffic between a computer network and the Internet. A technology consultant on contract can install these and other computer defenses. There is a lot of information about computer safety available, and often for free. Existing businesses will take advantage of myriad Internet applications— from customer service to order processing to investor relations.

8.2. Whey Protein Powder Marketing

Whey Protein Powder Business Marketing is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individuals' and the Whey Protein Powder Businesses goals. Marketing starts with the Whey Protein Powder Businesses mission:

- How does it define itself
- What are its goals?
- Who are its customers?

The marketing process performs certain activities as the goods and services move from producer to consumer. All these activities or jobs are not performed by every firm. However, they must be carried out by any company that wants to operate its marketing systems successfully.

Selling

It is core of marketing. It is concerned with the prospective buyers to actually complete the purchase of an article. It involves transfer of ownership of goods to the buyer. Selling plays an important part in realising the ultimate aim of earring profit. Selling is enhanced by means of personal selling, advertising, publicity and sales promotion. Effectiveness and efficiency in selling determines the volume of company's profits and profitability.

Buying or produsing and assembling

It involves what to buy, of what quality, how much from whom, when and at what price. People in business buy to increase sales or to decrease costs. Purchasing agents are

much influenced by quality, service and price. The products that the retailers buy for resale are determined by the needs and preferences of their customers. A manufacturer buys raw materials, spare parts, machinery, equipment's, etc. for carrying out his production process and other related activities. A wholesaler buys products to resell them to the retailers. Assembling means to purchase necessary component parts and to fit them together to make a product. 'Assembly line' indicates a production line made up of purely assembly operations. The assembly operation involves the arrival of individual component parts at the work place and issuing of these parts to be fastened together in the form of an assembly or sub-assembly.

Assembly line is an arrangement of workers and machines in which each person has a particular job and the work is passed directly from one worker to the next until the product is complete. On the other hand, 'fabrication lines' implies a production line made up of operations that form or change the physical or sometimes chemical characteristics of the product involved.

Transportation

Transportation is the physical means by which goods are moved from the places where they are produced to those places where they are needed for consumption. It creates place, utility. Transportation is essential from the procurement of raw material to the delivery of finished products to the customer's places. Marketing relies mainly on railroads, trucks, waterways, pipelines and air transport. The type of transportation is chosen on several considerations, such as suitability, speed and cost. Transportation may be performed

either by the buyer or by the seller. The nature and kind of the transportation facilities determine the extent of the marketing area, the regularity in supply, uniform price maintenance and easy access to the supplier or seller.

Storage

It involves holding of goods in proper (i.e., usable or saleable) condition from the time they are produced until they are needed by customers (in case of finished products) or by the production department (in case of raw materials and stores); storing protects the goods from deterioration and helps in carrying over surplus for future consumption or use in production. Goods may be stored in various warehouses situated at different places, which is popularly known as warehousing. Warehouses should be situated at such places from where the distribution of goods may be easier and cheaper. Situation of warehouses is also important from the view of prompt feeding of emergency demands. Storing assumes importance when production is regional or consumption may be regional. Retail firms are called "stores".

Standardization and grading

The other activities that facilitate marketing are standardisation and grading. Standardisation means establishment of certain standards or specifications for products based on intrinsic physical qualities of any commodity. This may involve quantity (weight or size) or it may involve quality (colour, shape, appearance, material, taste, sweetness etc.) Government may also set some standards, for example, in case of agricultural products. A standard conveys a uniformity of the products. Grading means classification of standardised products into certain well defined classes or groups. It involves

the division of products into classes made of units possessing similar characteristics of size and quality.

Grading is very important for raw materials, marketing of agricultural products (such as fruits and cereals), mining products (such as coal, iron and manganese) and forest products (such as timber). Branded consumer products may bear grade labels A, B, C.

Financing

It involves the use of capital to meet financial requirements of agencies dealing with various activities of marketing. The services to provide the credit and money needed, the costs of getting merchandise into the hands of the final user is commonly referred to as finance function in marketing. In marketing, finances are needed for working capital and fixed capital which may be secured from three sources—owned capital, bank loans and advance and trade credit. (Provided by manufacturers to wholesaler and by the wholesaler to the retailers.) In other words; various kinds of finances are short-term finance, medium-term finance, and long-term finance.

Risk taking

Risk means loss due to some unforeseen circumstances in future. Risk bearing in marketing refers to the financial risk interest in the ownership of goods held for an anticipated demand including the possible losses due to a fall in prices and the losses from spoilage, depreciation, obsolescence, fire and floods or any other loss that may occur with the passage of time.

From production of goods to its selling stage, many risks are involved due to changes in market conditions, natural

causes and human factors. Changes in fashion or inventions also cause risks. Legislative measures of government may also cause risks. Risks may arise during the course of transportation. They may also be due to decay, deterioration and accidents, or due to fluctuation in the prices caused by changes in their supply and demand. The various risks are usually termed as place risk, time risk and physical risk, etc.

Market information

The importance of this facilitating function of marketing has been recognised only recently. The only sound foundation on which marketing decisions may be based is correct and timely market information. Right facts and information reduce the aforesaid risks and thereby result in cost reduction.

Modern marketing requires a lot of information adequately, accurately and speedily. Marketing information makes a seller know when to sell, at what price to sell, who are the competitors, etc. Marketing information and its proper analysis has led to marketing research which has now become an independent branch of marketing. Business firms collect, analyse and interpret facts and information from internal sources, such as records, sales-people and findings of the market research department. They also seek facts and information from external sources, such as business publications, government reports and commercial research firms.

Retailers need to know about sources of supply and also about customers "buying motives and buying habits". Manufacturers need to know about retailers and about advertising media. Firms in both these groups need information about 'competitor' activities and about their markets. Even ultimate consumers need market information about availability

of products, their quality standards, their prices and also about the after sale service facility. Common sources for consumers are sales people, media advertisements, colleagues, etc.

Marketing mix

Marketing your Whey Protein Powder Business is the important process of communicating the value of your products and/or service to potential customers, for the purpose of selling that product or service. The marketing mix is the combination of product, price, place and promotion for any Whey Protein Powder Business. The marketing mix and the 4 Ps of marketing are often used as synonyms for each other. In fact, they are not necessarily the same thing.n**"Marketing mix"** is a general phrase used to describe the different kinds of choices Whey Protein Powder Businesses have to make in the whole process of bringing a product or service to market. The 4Ps is one way – probably the best-known way – of defining the marketing mix, and was first expressed in 1960 by E J McCarthy.

The 4Ps are:

- Product (or Service).
- Place.
- Price.
- Promotion.

Marketing is integral to the success of your Whey Protein Powder Business, large or small, with its primary focus on quality, consumer value and customer satisfaction.

The marketing mix blends these variables together to produce the results it wants to achieve in its specific target market.

Business marketing

Small Whey Protein Powder Business Marketing is concerned with facing a set of decisions that larger businesses have already made. Big Whey Protein Powder Businesses have an existing business to build upon, whereas your small Whey Protein Powder Business has a clean slate upon which to write exactly the right story. Before sending messages into the marketplace, know your answers to these questions:

- What kind of customer do you want to serve?
- How will your product compete with existing options available to your prospective customer?
- What kind of business image will you need to build in order to gain your prospect's attention, interest, and trust?

Marketing plan

Marketing in an extremely competitive sector can be tough as pressure mounts to get attention in the thick of fierce competition in an area that feels like its continually closing in. One of the fundamentals of the planning process is deciding who your optimal clients are and the reasons they want to

purchase from your business. Establishing your niche market and focusing on the ideal customers will maximize interest, and means that your receipts will increase with no corresponding rise in your fixed costs. Marketing your company must focus on disclosing the advantages your goods supply.

You should ensure that your marketing develops the opportunities that your company requires. Unquestionably, you need your advertisements to reveal information about your products. You should ensure that:

• Your advertising supplies understandable, complete, information in relation to your businesses products and services,

• Your people function forcefully at sales events and important presentations

• Your publicity is stimulating and informative,

• Your flyers and sales information are simple enough for probable customers to understand,

• Your free samples and examples of your goods are fit for purpose and simple to demonstrate,

• Your businesses site correctly conveys specifics about what your company provides and

That your organizations brand is clear, steady and reflects the image that you want. If you can make certain that your advertising is understood by your employees and your possible buyers, and if you can supply the benefits and assurances that your advertising claims, then your Whey Protein Powder Business will develop into the turnkey venture you are looking for. The demand for goods is the amount that consumers will

be prepared to buy at a determined price - the supply is the quantity that you will be prepared to bring to the market for that rate. Marketing is merely the action of preparing and implementing a strategy to deliver your goods and services to buyers.

Marketing Strategy

Your marketing strategy should be positive, coherent, and achievable and must match your plan. You will need to evaluate why your marketing will win your company new clients. Your marketing strategy needs to be unambiguous as it is important to all of the operational actions in your Whey Protein Powder Business. A failure to market precisely and persistently will severely ruin your company. If future patrons get the wrong, or an uncertain, idea about your products then, not only has your organization blown its finite time and resources, you will have greatly heightened the likelihood of your business breaking down as, inevitably, you will have a huge amount of expensive, unsold, stock and your personnel will be constantly handling irritated buyers, that allege they have not paid for the same goods that you are promoting. If the market is flourishing, and general demand is comparatively high, then your venture can afford to wait, but your expenses will be higher than they ought to be and, as we witnessed in the economic recession, poor marketing coupled with false and confusing sales promotions makes the likelihood of attracting satisfied clients essentially impossible. You need to be certain that your ventures advertisements are focused on the goods your company actually supplies and are not establishing substantial headaches between your venture and its customers. At no point must you begin modifying every little thing your

company does to satisfy everybody. Your establishment can't afford to be all things to every buyer, excepting that you have an unlimited amount of cash in your very deep pockets!

Market research

Market research is very important, if you cannot figure out the market then your business is plainly supplying goods and services hoping, and not being certain, that they might sell. If you do not have any decent market research you are speculating and taking a huge risk; any research that you do should supply important knowledge and direction. Good market research compels you and your employees to estimate:

- Market conditions and likely customer expectations and how your company is focusing on these,
- Information about the sort of trending goods dominating the market,
- The contrasting pricing strategies and how they are seen by potential customers,
- Who makes the buying decision and where expected consumers go to get unbiased news and guidance,

What is the traditional system and charges for distribution or delivery that is anticipated for the industry and, purchasers usually have a couple of main motivations; to get a reward or to avoid loss - which do your target customers have?

These are all crucial in the potential customers's decision making mechanism. If the goods that you offer begin to be popular and rise in revenues are you certain you have the appropriate people to manage the extra orders? Long lead times for your new goods means your customers will go elsewhere.

• Has your venture trialed your services on your likely clients?

• Are you certain your products have the benefits the customers need?

• Are you certain your charges are correct for your potential buyers?

• Are you sure that your people are trained to provide the level of customer service your purchasers will expect?

You must make sure your marketing, and therefore your advertisements, clearly set out the benefits you supply.

In your Whey Protein Powder Business Plan you should record exactly where your purchasers will buy your goods and any commissions that you will be offering:

Where and in what manner will potential customers be able to buy your merchandise?

Will you employ external go-betweens or utilize your own sales force?

Can you supply clear evidence that there is sufficient demand to persuade a trader, wholesaler or independent salesperson to supply your goods?

Marketing, promotion and sales strategies

Your marketing strategy should be the map you follow to get customers and seriously boost the success of your organization. Your business needs to establish persuasive and cost-effective advertising campaigns to develop sales leads. Your companies' sales strategy should concentrate on improving your lead conversion percentage to create greater earnings. Create a log for putting into action your marketing, promotion and trading strategy. It is obvious that you need to select the niche market for your goods and services; sadly a lot of small business owners completely pay no attention to this and try to sell everything to everybody at any price. This means the organization winds up with unmanageable overheads and

far too much stock, together with sales and customer service employees that are overstretched and cost more than the venture makes. They also have far too much stock that the company can, at no time, sell at a profit. Without a doubt, it does not matter how convincing your promotional campaigns and advertisements are, or how brilliant you are at showing the benefits of your goods, your business will lose money if you have not singled out your perfect customer.

The particulars in respect of the items that you supply should include:

• The straight forward needs and wants of your target buyers and the benefits your merchandise offer.

• Your products traits, nature or variances such as configurations, extent, color, weight, speed, sturdiness and range.

• The reasons your goods are dissimilar to your competitors.

• The method behind how you have established the wholesale and retail pricing for your businesses products.

Most ventures that go under offer a puzzling range of unconnected items and do not focus on dominating smaller niche markets, where they should have a tremendous competitive lead.

Your market analysis analyzes the status and the dynamics of your market and must contain:

• An analysis of general issues and your competitor's products with the idea of your business providing upgrades to their merchandise.

• A checklist of your competition, and you need to add information on any businesses that could enter the market during the next twelve months.

The where abouts status, advertisements, people, distribution methods, promotional campaigns and level of customer service of your competitors.

• Clear evidence that the market for your organization is thriving sufficiently so that there are an abundance of buyers for you.

An essential error made by new and small to medium sized ventures is that they compile plenty of wording from the net relating to the worldwide market, but disregard their real competition for the section of the marketplace that they are focusing on. Every entrepreneur that is successful got there by controlling niche areas of the market. It is critical for new or small to medium-sized companies to single out their target market and direct all of their finite assets on researching that, instead of the global market. Your plan needs to offer plenty of research about the growth within that target market and needs to be supported by convincing and appropriate data.

8.3. Types of whey protein powder marketing multi-level marketing

Multi level marketing (mlm marketing) is a form of direct selling. Companies market goods and services through networks of people who are called independent distributors. These people either buy products for themselves from the company or then resell them to consumers. They can also refer people to the company and when someone buys, they get a commission. Another way that these independent distributors

make money is by building their own sales organizations by providing their team with some great mlm training material and receiving commissions or bonuses from the sales generated by the independent distributors in their organization.

Direct mail

Using mail shots to get the attention of customers is very common and is done via the postal system. E-mails can also be used to do the same job and can be the more cost-effective approach. Promotions such as leaflets, brochures and newsletters are often the main content for mail shots, although there are no limitations.

Mail shots can reach a large audience, cheaply

Although you must appreciate that most people will show no interest towards your mail, you can reduce this effect by targeting your audience using mailing lists. Further, not only will you be saving money targeting uninterested parties, but also you will reduce the effect of people giving your business a bad image through the continuous receiving of unwanted mail (junk mail).

Telemarketing

Telephone calls can be used to make independent sales or can be used as a follow up procedure to mail shots. Once a customer has received and browsed your mail, they may have little or no intention to act and so a telephone call may just build up their level of interest. Telephone sales can be very annoying to most people, so again, it is important that you target your customers to avoid wasting their time and yours.

Sales can be made directly by phone... do you have someone capable of doing this?

If you are trying to make a sale over the phone, many people may never have heard about your Whey Protein Powder Business or seen your product, so you may decide to use telemarketing to draw people to your shop, office or even web site. If they are interested, you can then make appointments for them to visit so that you can offer them personal assistance and information regarding the product or service.

Internet marketing

Most people now regularly access the Internet for information, products and services. All Whey Protein Powder Business owners have turned their attention to the Internet because it reaches so many people so quickly and strong and defined Internet Marketing is vital for all Whey Protein Powder Businesses. Sales can be increased dramatically without a massive increase in expenses. Companies with a retail outlet have employees and other expenses that are not always needed online. There will still be advertising costs, web design costs, search engine optimization costs, affiliate or joint venture costs but the increase in overheads will not be substantial.

There now exists two types of Internet users:

• Those who are in pursuit of the latest and fresh information about anything of interest and

• Those who are seeing the Internet as an opportunity to earn huge potential revenues.

Internet marketing advice

There are many ways of making money online, many Internet-based business models that you can follow. The path that you will take will depend on your personal working habits, your interests, and the marketing style you are comfortable

working with. Here are some of the common forms of Internet marketing at a glance.

Brick and mortar online store- there are various corporate organizations and retail shops that created Internet versions of their brick and mortar store. Even people do not buy online; many marketers use these specific sites to gather product information before making purchases in the real world.

Online-based services- various industries have moved online—from dating, travel, banking, and even getting a college degree. You may earn from these as an extension for any of these service industries.

Internet-based products by internet gurus- Internet marketing has the wide array of pioneers and successful marketers who have started the methods and techniques in online marketing—creating sites, pay-per-click advertising, articles marketing, and others.

Online promotion and advertising- these include pay-per-click advertising programs (such as Google AdWords) that earns from highly-searched keywords, which became the main driving force behind most online-based financial transactions.

Affiliate marketing- you will join an affiliate program and promote its products and services over the Internet. You will endorse the products or services, find potential clients for the affiliate company, and you will receive certain commission for every sale that you will make out of your marketing efforts. The commissions that you will receive can run from 2 to 50 percent, depending on the terms and conditions stated under the affiliate program. One affiliate click can generate several cents to a hundreds of dollars.

Online Marketing

There are 3 keys to Online Marketing success.

• Keyword Research. Find popular subjects and keywords/ phrases, using a keyword selector and suggestion tool by Overture and 7Search

• Writing Articles. Write original content with keywords from your research.

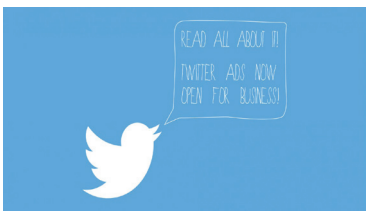
• Quality Content Site. Build a quality content site incorporated with Google Adsense ads that target the subject and keywords of your article and website.

Social nedia narketing

Social media is the interaction among people in which they create, share, or exchange information and ideas in virtual communities and networks. There is an increasing trend towards using social media marketing using tools that allow marketers to search, track, and analyze conversation on the web about their brand or about topics of interest. This can be useful in marketing management and campaign tracking, allowing the user to measure return on investment, competitor-auditing, and general public engagement. Tools range from free, basic applications to subscription-based, more in-depth tools. Social networking users has increased by 25% in the

last three years and Facebook, Tumbler and Twitter are far ahead in terms of number of users as compared to other social networking sites. In Africa, the market of social networking is at nascent stage of developments with only 38% of users active at any point of time but in Europe around 2/3rd of total users are logged in at least one of the social networking sites with over 60% of users logged in at Facebook and around 15-17% on Twitter at any point of time. In Japan, the number of users on Twitter had grown by more than 500% in the last two years alone. These are the few indicators for the popularity of social networks around the globe and this growth is reflected in the United States.

Most of the social networks are free for the users, which allow marketers to reach target audiences at a very low cost, which is a major driver for the growth of social networks. Moreover, the ease of use, user-friendly interface and instant information sharing features of the social networks are the major drivers for the social networking market. However, concern over the identity thefts and security of personal information remain the restraining factors for the growth of social networks around the globe.



Twitter narketing

Twitter is an online social networking and microblogging service that enables users to send and read short 140-character

text messages, called "tweets". Registered users can read and post tweets, but unregistered users can only read them. With 500 million Tweets a day and 230 million active users, people turn to twitter to bring them closer to the things they care about, whether it's the news that affects their lives or the businesses down the block. Nearly 60% of tweets are sent from mobile devices meaning that around 150 million people are constantly using twitter. Twitter has a market capitalization of around $33 billion and has now published its first results as a public company.

E-mail narketing

Including e-mail in your marketing mix is not as simple as transferring more traditional message formats into electronic formats or abandoning more expensive mediums in favor of e-mail delivery.

Maximizing your business' **e-mail marketing** potential involves two ongoing tasks:

• Analyzing the strengths and limitations of each medium in your marketing mix

• Developing messages that work harmoniously across multiple mediums to achieve your objectives

Monetizing your website

Monetizing your website covers the way you will translate your sites traffic into earnings and there are a number of ways that you might use to create income.

Online store

For organizations that supply goods and services an online store offers real benefits that includes improved income and, obviously, the chance to market deals and bargains swiftly and simply. A web store should be quick and easy to organize and there is an unlimited range of software to assist you with the job. Your online store is open all the time and should have an automated order and payment processing system. Purchases can be made at any time of day and clients can purchase whenever it suits them.

Pay per click advertising

Pay per click is a web advertising technique that is utilized to generate earnings from traffic to your site; advertisers make payments when their advertisement is clicked on by your website visitors. Assorted advertising networks assist website owners in placing advertising on the pages of their site, generating income from the traffic the website is getting.

Display advertising

The most popular form of site monetization, display advertising, encompasses the banner and content ads that appear on a lot of websites. This income should be increased by the use of search engine marketing and by more activity on social media.

Online advertisements are especially worthwhile if you provide interesting wording that matches the advertisements on the page.

Affiliate marketing

Affiliate marketing is connected with selling another organizations merchandise by placing a link to their store on your pages; if that organization converts the click to a sale, you receive an agreed percentage of the money they collected. 78% of affiliate programs today utilize income splitting or payment per sale as a compensation system, eighteen percent use payment per response, and the other programs utilize practices including pay per click. This is an excellent approach to produce increased cash if you are a niche seller in a wider market as you could generate revenues without the associated costs.

Subscription service

Subscription revenue is created by invoicing website visitors to access extra online wording. Continuity or compensated membership plans are a wonderful method of monetizing current traffic; some sites make some free content accessible and then charge a monthly fee for further access to exclusive content or personalized advice. This can be especially handy if you provide high-priced services as you can establish solid relationships with future clients that would then be transformed into bigger revenues.

Monetizing your website marketing blog

With so many blogs on the Internet how do you make yours known and get people to read it. How do you have the most often read blog on the market that you are promoting?

There are so many people that are trying to all accomplish the same thing, how are you going to stand out? There are several things that you can do to make your blog a success. The first thing that you should know is that you should have your blog URL pointing to your market. For example, if you are trying to promote and sell from your blog then you want your URL to include the product name as doing so will give you an extra advantage.

The next step would be to customize your blog. Rather than having the same old blog interface like everyone else has, make your unique and interesting to look at. This will also help anyone from getting your blog confused with others that look just like it. There are so many types of blog software on the market that having your own look should not be that difficult to accomplish.

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9. THE ENVIROMENTAL IMPACT OF THE DAIRY PROCESSING INDUSTRY AND WHEY

by Cia Umbria

Confederazione italiana agricoltori dell'Umbria

in collaboration with Eurocultura

eurocultura

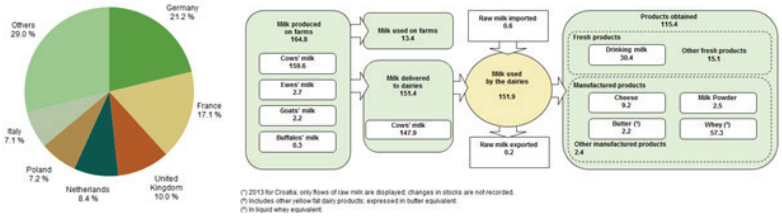
Perugia, 13 February 2016

9.1 Introduction to an environmental approach

For over 30 years, the EU's dairy sector has operated within the framework of milk quotas, which were introduced in 1984 to address problems of surplus production but expired in April 2015. Until then, each EU Member State had two quotas: one, the majority, for deliveries to dairies and the other,

limited amount, for direct sales at farm level. Milk production data were used for signalling imbalances in the market that, if serious enough, would trigger public intervention (of butter and skimmed milk powder) and/or private storage. Moreover, when national quotas were exceeded, punitive 'super-levies' were recovered from the farmers or dairies involved. Farms across the EU-28 produced approximately 164.8 million tonnes of milk in 2014, of which 159.6 million tonnes (or 96.8 %) were cows' milk. Milk from ewes, goats and buffalos represented 3.2 % of the total production. Turkey is also a strong milk producer, with more than 18 million tonnes of milk. (Eurostat, 2015). The dairy sector is therefore, as demonstrated from the figures, one of the most important for the agri-food industry in the European Union (EU). Milk is produced in every single EU Member State without exception and dairy is the most prominent sector in many regions of the EU, also including regions of particular landscape and environment value, e.g. mountainareas.

The EU is a major player in the world dairy market and is the leading exporter of many dairy products, most notably cheeses. In addition, the food industry uses many sophisticated dairy-based ingredients. From the dairy industry of 115.4 million tonnes products obtained, 57.3 are constituted of whey (in liquid equivalent).



In 2007, the dairy sector emissions were calculated as 1,969 million tonnes CO2-eq, of which 1,328 million tonnes were attributed to milk, 151 million tonnes to meat from culled animals, and 490 million tonnes to meat from fattened calves. The global dairy sector was estimated to contribute 4.0 percent to the total global anthropogenic GHG (greenhouse gas) emissions, according to studies conducted by FAO in 2010, including emissions associated with milk production, processing and transportation, as well as the emissions from meat production from dairy-related culled and fattened animals. The most recent FAO study in depth on the same issues (Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities, 2013) calculated dairy sector emissions largely higher than estimated before: 7,100 million tonnes CO2-eq, that is 14,5 percent of the total anthropogenic GHG emissions. The main emission sources are: the production and processing of animal feed (45 percent of the total), the digestive process of cows (39 percent), and the decomposition of the manure (10 percent). The rest is due to the processing and transportation of animal products.

The footprint of a given farm is composed of three clusters of impacts on: i) air quality and the atmosphere via net greenhouse gas (GHG) emissions, and the loss of ammonia and nitrogen in any of several chemical forms from the soil,

livestock housing, and manure management, ii) water quality and aquatic ecosystems as a result of erosion and runoff containing fertilizer nutrients, pesticides, animal drugs, and pathogens, and iii) soil and terrestrial ecosystems and water quality from cropping practices, fertilizer and pesticide applications, and manure management.

It means dairy sector has an heavy ecological footprint on the Earth's ecosystems and it is necessary therefore to act to reduce its environmental impact.

This is possible by following correctly sustainable procedures at all steps of the dairy supply chain, from breeding to milk/cheese plants, transports and ditribution, also focusing on waste reduction and virtuous use of by-products, such as whey. Actually the applications for dairy products are constantly expanding as research and innovation bring in new technologies, novel food formulations, improved composition and "functional foods". The high footprint values related to livestock breeding and animal production make necessary to set up all techniques and technologies needed to decrease GHG in this sector. Nevertheles, the GHG absolute values are not the only analysis way for appropriate benchmarkings within the agri-food sector. A recent paper published in Food & Nutrition Research (Smedman A, Lindmark-Månsson H, Drewnowski A, Modin Edman A-K., Nutrient density of beverages in relation to climate impact, 2010) contributes to the important research area of how to achieve nutritional goals while reducing the amount of GHG emissions from the food system. The paper introduced a novel method of measuring the nutrient density of a food or drink in comparison to GHG emissions associated with the production, manufacturing,

packaging, and transportation of that food or drink, using a life-cycle perspective index called Nutrient Density to Climate Impact (NDCI). The authors of the paper used the NDCI index to compare eight beverages: milk, soft drink, orange juice, beer, wine, bottled carbonated water, soy drink, and oat drink. The NDCI index for milk was higher than for the other beverages, and the authors concluded that 'milk both has the highest nutrient density per se, and has the highest nutrient density in relation to GHG emissions of the compared beverages. It can be therefore assumed that the NDCI index is a tool that facilitates inclusion of a nutritional aspect of the climate debate. Nutrition recommendations must not only fulfil public health goals, but also economic aspects and sustainable development of society. Tools such as the NDCI index can be considered essential to addressing such issues. It is thus important to use both knowledge in nutrition and climate to avoid simplistic and erroneous conclusions for food recommendations and dietary guidelines to mitigate climate change. More in general, the most appreciated and generally accepted approach to an environmental analysis is Life Cycle Assessment (LCA), that is an environmental study focusing on the complete life cycle of a product or a service, from resource extraction to end-of-life of products considering all steps in between, by quantifying the environmental impacts, such as climate change, ecosystem quality (i.e. aquatic acidification and eutrophication), human health, resources (energy and water). For the dairy sector LCA have to be considered farm production (fodder, cow raising, milking, at farm refrigeration), packaging, dairy processing (processing for production of various dairy products), distribution (transports and retailers), use phase and end-of-life. Going to the details of milk processing to make cheese,

whey is considered a very critical point, since the part still currently used as a by-product is, depending of countries, no more than 30 percent, whilst the potential value, in terms of proteins and other kind of applications is very high.

9.2 EU Regulations on animal by-products and derived products not intended for human consumption and use of whey

Regulation (EC) 1069/2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and its accompanying implementing Regulation (EC) 142/2011 entered into force from 4 March 2011 and replaced, with the accompanying implementing rules, Regulation (EC) 1774/2002. Animal by-products can present a risk to human and animal health, in particular in relation to Transmissible Spongiform Encephalopathies (TSEs), dioxin contamination, and exotic diseases such as Classical Swine Fever and Foot and Mouth Disease. Regulation (EC) 1069/2009 and its corresponding implementing Regulation (EC) 142/2011, replacing Regulation (EC) 1774/2002 is the consequence of a long and comprehensive review carried out by the EU Commission to assess the operation of EU-wide controls on animal by-products. The distinction between foodstuffs and animal by-products is clarified by confirming that operators need to make an irreversible decision if products are destined for purposes other than human consumption.

This means that once a product has become an animal by-product, it must not re-enter the food chain.

The main by-products from dairy processing are: whey, buttermilk and effluents.

Whey or serum is a greenish-yellow turbid liquid, which remains in the boiler after separation of the curd and is distinguished, relative to the origin of the milk, in sheep, buffalo or vaccine whey. It contains all the elements of the soluble milk which did not directly participate in coagulation, which are mainly lactose, whey protein and soluble salts, together with fat to an extent depending of the curd processing. With regard to the composition of the whey, it varies in function of different factors, such as the particular species, the power of this, the breed, the season milk production, stage of lactation, the type of cheese used and the type of processing to produce it. The specific weight of the whey is about 1.025 to 1.030 at 15°C. The composition of the whey depends of the technology used in cheese making, in particular the variations are due to the system of casein coagulation and the level reached by the lactose fermentation, the content of calcium and phosphorus in the whey depends on the type of milk coagulation. The cheesemaking process also influences the fat content and lactic acid and all of these factors influence possible uses of whey.

Buttermilk is the by-product that originates from the process of production of mozzarella cheese and butter in the phase of the churning of the cream.

Effluents contained in the dairy industry wastes are represented by residues in milk and its by-products and some substances used in agro-food industry; these should be added to the products used in the washing and disinfection of the rooms, equipments and complementary services. Surveys carried out showed that the quantitative and qualitative characteristics of the liquid whey and in general of the wastewater of the dairies are not always easy to determine, by varying in relation to type of processing adopted, size of the processing plants, etc.

9.3 Environmental guidelines for dairy processes

The dairies are establishments designed to prevent alteration of properties and composition of milk so that it can be preserved as much as possible intact and stable over time. The processes that are adopted are essentially the pasteurization, sterilization and aseptic packaging of the product obtained. In these establishments, in addition to the main product (milk for direct consumption), also other products, such as butter and cream, are obtained.

Butter production process in dairies of modest working capacity is applied to the pattern of traditional processing that provides a processing line discontinuous and slow; in these dairy equipment for the churning being essentially represented by a churn stainless steel and a kneading/molding.

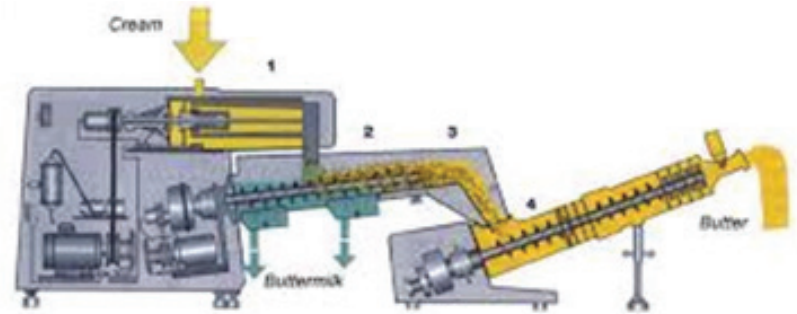


Fig. 12.6 A continuous buttermaking machine.

1 *Churning cylinder*
2 *Separation section*
3 *Squeeze-drying section*
4 *Second working section*

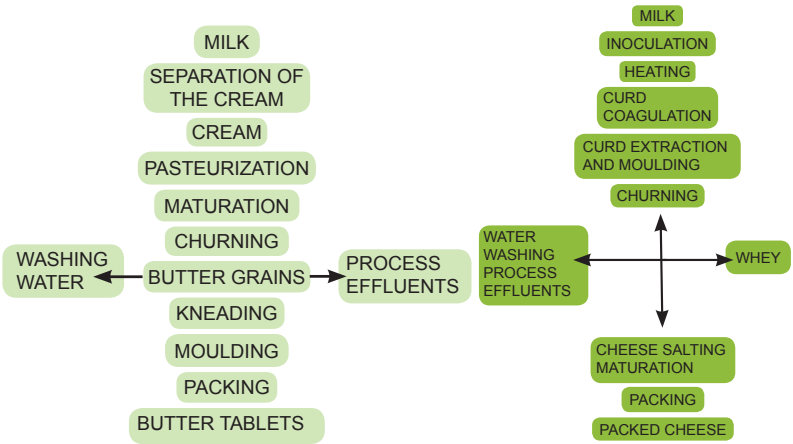
On a large scale, however, the process of butter making process is carried out with computerized systems through a continuous process, which repeats the same operations of processing discontinuous, but with saving of time and labor and increased hygiene (Fritz, Alfa, Senn and Golden-Flow are the most used processes). The difference in terms of the characteristics of the final product to the percentage of fat contained in the butter, and then of that lost in the buttermilk (in the Senn process the loss of fat in the buttermilk is only 0.15-0.20%). With the formation of grains of butter, we proceed in the same churn to remove buttermilk, whose title of fat is normally less than 0.5%; follows the step of washing with water which allows the removal of the by-product residue. This washing operation is normally repeated 2-3 times. Cream and butter are viscous and fatty and stick to equipment surfaces much more strongly than liquid milk, increasing the problem of removing residues. Hot water is an effective way to remove residual butterfat from cream processing and butter making equipment but the water temperature must not be too high (< 65C) or there is the risk of "burning on" of some of the proteins. Whey should be dried where possible. To avoid spills, buttermilk collection facilities should be large enough to hold all buttermilk discharged. Buttermilk should be dried or used as animal feed and solids recovered from butter wash water also may be sold as stock feed.

Relatively to the volume of water used in these establishments, the data reported in literature show considerable variability, indicating the existence of differences far from negligible. This heterogeneity is primarily dependent on the different types of plant and then the recovery more or less stringent waste water and cleaning solutions, and secondly,

the greater or lesser availability of water, and also the staff behaviours.

The ratio between water consumption and milk processed in different plants varies between 4: 1 and 2: 1, with the lowest values in the smaller ones.

Cheese scheme of production is very variable depending on the type of finished product, or of its peculiar organoleptic characteristics and product. Regarding the yield of milk in cheese it is also known that this is related mainly to the amount of protein nitrogen and casein present in the milk inlet. To better understand the traditional butter and cheese making process, it is shown in the following synthetic scheme.



The selection of a site for the construction, replacement or expansion of a dairy plant should take into consideration nearby land uses, possible future developments, the volumes and nature of wastes produced and the proposed nature of waste recycling, reuse or disposal. Generally, soils with textures

ranging from medium loams to medium clays are suitable. Sandy soils are not suitable because of the risk of leaching of contaminants into underlying groundwater. Similarly, wastewater should not be applied to heavy clay soils where water logging or surface run-off may occur.

Depending on the proposed waste disposal system, adequate land should be available for treatment of wastewater.

An ideal buffer distance between dairy processing operations and residential areas would be at least a kilometre. Dairy plants and their associated wastewater treatment plants should not be located on a flood plain and should be a sufficient distance from surface water bodies and wetlands to reduce the risks of contamination caused by run-off or accidental spills. Similarly, wastewater treatment and disposal areas should not be sited above major ground water recharge areas such as gravel or sand beds or fractured rock aquifers.

Siting should also consider the need to protect sensitive natural water resources. Thus a dairy plant should not be sited within 100 metres of surface waters, nor be located on a flood plain or in declared special water supply catchment areas.

Emissions in the air, mostly constituted of odours and particles, are also to be prevented as much as possible and taken under control. Odours in and around milk processing plants come from the biological decomposition of milkderived organic matter, generally found in wastewater.

Often these odours are due to poor housekeeping, overloaded or improperly run. Particle emissions are caused either by combustion of solid or liquid fuel or, more often, spray drying of milk and whey. Excessive emissions are

often sporadic and happen during plant upsets, shutdowns or startups. It is necessary therefore to set up adequate measures to limit emissions in the air:

• Maintain aerobic conditions for wastewater processing;

• Use filters or scrubbers to eliminate or reduce particles;

• Use automatic process control;

• Carry out continuous routine monitoring of emission points using audible, visible alarms.

Noise is also to be taken under control by measures based basically on good construction criteria for plants, soundproofing walls and use of silenced plant equipments, correct maintainance of equipments, restricted operating hours and noise assessment procedures.

In order to be more sustainable, dairy processing plants should be designed, built and operated to achieve:

• maximum recovery of products such as milk fat and solids;

• minimisation of losses or emissions to the environment;

• recycling and/or reuse of wastes;

• prevention of further environmental degradation;

• restoration of the environment;

• appropriate location of the plant to minimise the impact on residents;

• waste management, to avoid degradation of the community environment.

The principle to be followed should be based on waste minimisation, deriving of a reduce-recycle-treatment-dispose model, that can be shown as in the following scheme:

Waste reduction measures may include:

• reducing use of water

• reducing use of chemicals or substitution of mineral salts (i.e. potassium in place of sodium compounds);

• recycling water and chemicals;

• recovery and reuse of product from first reuse;

• recovering and reusing spilled raw materials and products.

Dairy configuration and the products made affect the nature and concentration of dairy wastes. The amount of product lost depends on design and operational factors as sources of waste:

• the range of process technologies in use;

• the availability of adequate process monitoring, and plant and procedure alarms/interlocks;

• the availability of automated operation–especially automated clean-in-place (CIP) systems and procedures;

• the level of management and operator commitment, training and efficiency;

• the level of routine equipment maintenance.

Compliance with some general guidelines can help to keep under control the environmental impact of a given dairy process, as in the following synoptic table.

PLANT	• area and layout for works • noise attenuation works
PROCESSES	• prevent spillages • purge lines • automate CIP systems • maintain equipment • recover and recycle wast (membrane technology) • monitor processes (alarms, interlocks) • new technology
PERSONNEL	• waste management program • staff training

Some examples of avoidable losses, mostly due for liquid handling and, to a lesser extent, solid waste and discharge of air, are:

• leaking valves, pumps, pipelines or other fittings (the volume lost may not be large but the pollution load may be great);

• spills from overflows, malfunctions and poor handling procedures (spills usually happen over a short time but the amount and high concentration of loss may be a significant increase in the pollution load);

• losses from processing and cleaning during the normal operation of plant and equipment, that include the deliberate discharge of unwanted materials such as whey, spent cleaners and diluted product not thought to be worth recovering.

Butter and dried products

Best practice involves processing the predominant by-products such as whey, buttermilk and skim milk, into high value products like skim milk powder (SMP), buttermilk powder (BMP), whey powder, whey protein concentrate

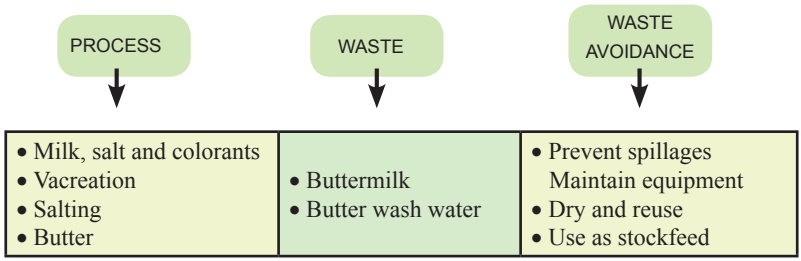
and casein, rather than being used as low value animal feed/ fertiliser or being dumped as waste. Cream and butter are viscous and fatty and stick to equipment surfaces much more strongly than liquid milk, increasing the problem of removing

residues. Hot water is an effective way to remove residual butterfat from cream processing and butter making equipment, but the water temperature must not be too high (< 65°C) or there is the risk of "burning on" of some of the proteins.

Whey should be dried where possible.

Liquid effluents that most frequently occur for the process of butter making process are:

- washing water from containers for the storage and pasteurization of milk and cream;
- washing water from containers for butter kneading;
- water used in degasifiers, cells cooling and conditioning of the warehouses;
- water used at the end of the working day for cleaning rooms and external parts of the machinery



For the cheese making process the following types of wastewater originate:

• washing water from containers for the coagulation of milk;

• curd cleaning, whose quantitative and qualitative characteristics vary according to the type of cheese produced;

• exhausted pickle water from salting;

• water used for cell cooling and conditioning of the warehouses;

• water used at the end of the working day for cleaning rooms and external parts of the machinery.

Cheese and dried products

Making cheese generates a large volume of byproducts such as whey.

Waste reduction can be achieved by:

• not overfilling cheese vats to stop curd loss

• completely removing whey and curds from vats before rinsing

• segregating all whey drained from cheese

• sweeping up pressings (particles)

• screening all liquid streams to collect fines.

PROCESS	WASTE	WASTE AVOIDANCE
• Milk, salt and culture • Salting • Ripening • Pressing • Cheese	• Wastewater • Whey • Curd • Pressings	• Reduce spillages • Collect all whey and cheese • Compress pressings by sweeping

Evaporation and powder production

It is suggested that evaporators be operated to:

• maintain a liquid level low enough to stop product boil-over;

• run to specified length (excessively long runs with higher than specified running rates lead to blocked tubes which produce high pollution and are difficult and time-consuming to clean;

• use effluent entrainment separators to avoid carry-over of milk droplets during condensation of evaporated water;

• recirculate low concentration milk or other feed-stock until it reaches the required concentration;

• process rinsings with 7% or more of solids before scheduled shutdowns, or evaporate them during the next run rather than discharging to the sewer;

• minimise air emissions by using fabric filters or wet scrubbers.

• Milk • Evaporation  • Powder production  • Milk powder	• Milk • Energy • Wastewater • Particulates	• Prevent product boilover • Run to specified run length • Avoid carry over of milk droplets during condensation • Recirculate low concentration milk • Reprocess rinsings > 7% solids • Use rinsings <7% for stock feed • Air or dry sweep • Fabric (bag) filter • Wet scrubber

Sources of dairy wastewater

Approximately 65% of dairy factory losses enter wastewater discharge streams and these can have a major impact on the environment. The main sources of dairy processing plant wastewater are:

• raw material (predominantly milk) and product losses from leaking equipment and pipelines, and spills caused by equipment overflows and malfunctions and by poor handling procedures;

• materials used for cleaning and sanitising;

• by-products such as whey from the manufacture of cheese and casein.

Whey has a BOD (Biochemical Oxxygen Demand) concentration of 30,000-40,000 mg/L. Where the whey is not used as a by-product but is discharged as effluent, it will increase the BOD level of wastewater and cause treatment and disposal problems.

Options for dairy factory wastewater include: i) treatment to a suitable standard for reuse or recycling, ii) discharge to local authority sewers under a trade waste agreement (with pre-treatment as necessary), iii) appropriate treatment and land discharge wherever practicable.

A risk analysis plan avoiding unwanted discharging of waste will be necessary, starting from an adequate knowledge of waste sources originated and relevant safe environmental management.

Dairy processes	Sources of waste
Milk receiving/storage	•poor drainage of tankers •spills and leaks from hoses and pipes •spills from storage silos/tanks •foaming •cleaning operations
Pasteurisation/ultra heat treatment	•liquid losses/leaks •recovery of downgraded product •cleaning operations •foaming •deposits on surfaces of pasteurisation and heating equipment
Homogenisation	•liquid losses/leaks •cleaning operations
Separation/clarification (centrifuge, reverse osmosis)	•foaming •cleaning operations •pipe leaks
Product processing stages	
Market milk	•foaming •product washing •cleaning operations •overfilling •poor drainage •sludge removal from clarifiers/separators •leaks •damaged milk packages •cleaning of filling machinery
Cheese making	•overfilling vats •incomplete separation of whey from curd •using salt in cheese making •spills and leaks •cleaning operations
Butter making	•vacreation and salt use •produce washing •cleaning operations
Powder manufacture	•spills of powder handling •start-up and shut-down losses •plant malfunction •stack losses •cleaning of evaporators and driers •bagging losses

9.4 Whey sustainable use: composition, properties and innovative applications

A responsible management of dairy processes assumes, as previously highlighted, full knowledge of all the production steps, avoidance of unwanted discharging of effluents in the environment and reuse, as much as possible, of the greatest part of whey, that can be considered a part that can be valorised instead of discharged as a waste.

Whey re-entering of whey in the dairy process is possible for making "ricotta" and similar kinds of soft cheese, whilst a larger whey quantity is used for production of lactose and whey powder. Buttermilk is traditionally used for feeding pigs, as well as for the extraction of casein and a series of valuable substances for the pharmaceutical industry.

The chemical-physical and microbiological characteristics of whey and buttermilk are extremely variable, especially in relation to the type of product and size of the industry. In the very last years protein powders have been becoming more and more interesting for scientists and pharmaceutical industry for their healthy and antiaging benefits. As a by-product whey contains higher amounts of protein than other natural ingredients, depending of the specific dairy process. There are three main types of whey protein supplements: i) Whey Protein Concentrate, ii) Whey Protein Isolate and iii) Whey Protein Hydrolysate. Whey Protein concentrate is the cheapest of all three whey protein powders. It has the lowest amount of protein, around 58 to 89%. The rest is composed of fat, lactose and immune-enhancing peptides like alpha-lactalbumin and immunoglobulin. The percentage of WPC depends on how concentrated it is. Lower end concentrates have 50% protein,

while higher end ones have up to 90% protein. Whey Protein Isolate contains 95% of the protein, with minimum amount of lactose and fat. Whey Protein Hydroslate has 99% of protein and is the most expensive of all the whey protein powders. It is considered the "pre-digested" form of whey protein, as it undergoes partial hydrolysis, a process necessary for the body to absorb protein. It is the most soluble form of protein, quickly digested in the body and considered the best whey diet protein supplement. The use of whey protein as a source of amino acids, such as cysteine and methionine, and its effect on reducing the risks of diseases such as heart disease, cancer and diabetes has been also the focus of ongoing research since 2000. Evidence of therapeutical anti-cancer actions of the whey proteins are currently under trials. These traditional or more recent valorisation of whey and buttermilk can be followed and supported by farmers' associations and dairy producers at all level.

Nevertheless, still a large part, estimated about 30 percent average of the total whey and buttermilk, but much more in many countries, can not be valorised and are treated like wastewater from the dairy processes. In this case it is very important to observe the environmental management explained in the previous chapter in order to use even the effluents in the best possible way.

Referring to the average composition, the liquid whey and the waste materials appear to be substantially free of hazardous substances (pathogens, heavy metals, viruses, etc.) and provided with a high organic load.

They can be therefore considered as a source of organic matter of some agronomic interest containing different organic compounds (sugars, fats, organic acids, etc.) and various minerals (potassium , phosphorus, calcium, etc.). From an analysis of the literature regarding agricultural trials on the use of liquid whey and effluents can be observed that have been widely documented effects of increased production of several herbaceous crops in open fields, such as autumn-winter cereals, corn and forage crops, thanks to significant nutrient that the distribution of the wastewater involves (Sharratt et al., 1959; Sharrat et al., 1962; Di Menna, 1966; Peterson et al., 1979; Young et al., 1980; Peterson and Kelling, 1981 ; Radford et al., 1986; Robbins and Lehrsch, 1992; Jones et al., 1993; Harris et al. 1994; Lehrsch et al., 1994; Robbins et al., 1996; Roygard et al., 2001; Woodard et al., 2007). It has been also observed, however, that the applied doses were always quite high, ranging from 250 to more than 8000 m3 ha-1. Regarding the fertilizer value of dairy wastewater, it can estimated the amount of elements changed in assuming to use whey, with hot and effluent concentrations of N, P and K.

A well-designed dairy effluent collection and storage system is essential for the effective use of dairy effluent on farm. An effective effluent system also enhances the control and distribution of valuable nutrients back to sections of the farm that require them.

The two main options for managing dairy effluent, whether from a dairy shed or a feedpad facility, are:

• Direct application

This option collects effluent at a single collection point, and then transports it via pipes or channels to a suitable area on

the farm. Effluent can be applied to pastures and crops using a number of options, such as direct discharge, flood irrigation channels, fixed sprays, travelling irrigators and slurry tankers. As this option relies on daily application, effluent needs to be managed so that it is retained on the property and so that plants and soil absorb the nutrients. Farms with well-drained soil types that suit direct application also pump from sumps year round.

• Storage prior to application

This option allows effluent to be collected from more than one collection point and directed to an effluent storage pond. It provides much more control over runoff, and effluent applications can be timed to meet plant nutrient and water requirements and to fit labour availability, rather than having to apply effluent on a daily basis, even when it is raining. On irrigation farms, the effluent pond should be located near a main farm channel to maximise the irrigated area onto which the effluent can be spread. If farm channels are used as part of the distribution system with either option, only discharge dairy effluent into a farm channel in which water is flowing. This will avoid a build up of waste material and weed growth, which would interfere with the operation of the channel.

The most recent regulations have strongly limited possible use of effluents and wastewater dairies for fertilization purpose, since have been highlighted risk factors of ground water table pollution. These factors are represented by the pH, salinity and concentration of some elements, also in relation to climatic conditions and the crops affected (Woodard et al., 2002; Johnson et al., 2004).

In particular, it is already mentioned as the whey acid pH, that within a few hours reach values around 4. Great attention must also be paid to the salt concentration of the effluents, as well, it is not to be underestimated also the presence of disinfectants and detergents in the effluents, which can achieve, especially in the buttermilk, concentrations of between 0.35 and 1.20 kg/T, although biodegradable, many of these compounds could create problems if they were entering into direct contact with groundwater.

For these reasons innovative experiments are currently addressed to find new uses of whey in emerging sectors, such as renewable energy sources or chemical neutralization of dangerous wastes, such as asbestos.

Those virtuous re-use of dairy effluents, and particularly whey, can offer new opportunities of economic and sustainable valorisation within a vision of environmental footprint reduction.

BASIC GLOSSARY

Best practice

The practice of seeking out, emulating and measuring performance against the best standard identifiable.

Biochemical oxygen demand (BOD)

A measure of the oxygen demanding substances in wastewater, which indicates the level of pollution present. It records the number of milligrams of oxygen required by microorganisms to oxidise the organics in a litre of the water over a period of time. It is expressed as milligrams per litre (mg/L).

CIP

Clean-In-Place, refers to the use of a mix of chemicals, heat and water to clean machinery, vessels or pipe work without dismantling plant.

Effluent

The liquid discharged from a treatment unit or system. It is qualified according to the type of

treatment received (for example, sand filter effluent or treatment plant effluent).

Environment management plan

A plan covering the management of health and environmental risks.

Groundwater

Water located beneath the land surface.

Irrigation

The application of wastewater to land to replace soil moisture lost by evapotranspiration and to promote the growth of plants.

Nutrients

Substances that stimulate and enhance growth. Generally refers to nitrogen and phosphorus in waters.

Reclaimed water

Water that has been reclaimed from wastewater or sewage and treated to a standard which is satisfactory for its intended use.

Reuse

The application of appropriately treated wastewater for a specific purpose.

Sodium adsorption ratio (SAR)

A measure of the amount of sodium, relative to calcium and magnesium. SAR indicates the effect on soil structure and the reduced rate at which water moves through the soil.

Treated effluent

Effluent that has be subjected to biological oxidation and clarification (not disinfection) to secondary standard.

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10. THE BEST PRACTICAL APPLICATIONS IN THE PROJECT COUNTRIES

TURKEY

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As a general rule, it is accepted that almost 9 L whey is released from each kg of cheese produced. In accordance with this rule, data related to whey coming out has been calculated using data related to cheese production in our country and shown on Table 10.1.

Table 10.1. Cheese production in Turkey (TSI, 2012-2014).

Months	2012	2013	2014	2012	2013	2014
January	43395	45766	49018	2429	2292	2316
February	44558	45401	48977	2219	2281	2565
March	43861	47212	49831	1751	2186	2602
April	44203	48057	48851	1591	2152	2633
May	44606	48205	47561	1910	2036	2884
June	44045	48028	49875	1780	2332	2632
July	45920	48735	48535	2265	1967	2856
August	45746	47977	49290	2258	2178	2825
Septembe	46591	47014		2507	2110	
October	45643	48731		2179	2220	
November	44765	49642		2070	2347	
December	46227	49557		2026	2394	
TOTAL CHEESE	539560	574325	391938	24985	26495	21313
TOTAL WHEY	4856040	5168925	3527442	224865	238455	191817

In accordance with the data above, cheese productions in 2012 and 2013 are 539.560 tons and 574.325 tons, respectively. 5 million tons of whey is released every year in Turkey (Table 10.1).

Table 10.2. Amount of nutritional components in whey released every year in Turkey.

Component	Amount (ton)
Lactose	250.000
Protein	40.000
Calcium	2.500
Phosphate	10.000

Amounts of nutritional value foods such as protein and lactose released in whey every year in dairy industry in Turkey are shown on Table 10.2. Amounts of whey powder and lactose produced in 2012 in accordance with official records of T.R. Ministry of Food, Agriculture and Livestock are **74.369 tons** and **2.836 tons**, respectively. Amount of cheese production in 2012 is 564.545 tons (Table 10.1). **1.155 million tons** of whey has been used for production of almost 77.000 tons of whey powder and lactose in 2012. However, 5 million tons of whey is released per year in Turkey. It brings to mind that such an amount of whey is not utilized from or not used in production of any product due to the fact that any data related to **3.845 million tons** of whey do not appear anywhere.

The most leading sample for prevention of environmental pollution and utilization of waste water in our country is **Marmara Birlik Süt ve Süt Mamülleri A.Ş. (Maybi)**.

Malkara Birlik Süt ve Süt Mamulleri A.Ş has been found in Malkara County of Tekirdağ in 1993 in order to be supplier of many food producers transforming milk and whey into an industrial and ecological additive product. Production amount beginning within monthly capacity of 80-100 tons in the earlier stages has exceeded 1000 tons nowadays.

The firm having the largest plant in The Balkans operates in open area of 57.250 m^2 and closed area of 27.000m^2. The firm both dries and pulverizes first class raw cow milk collected from Thrace Region and also provides whey from neighbouring dairy farms, processes this raw material accepted as environmental waste within the latest technology and contributes into both environment and Turkish economy.

Products produced by firm can be sorted as whey powder, skimmed milk powder, demineralised whey powder and lactose. Maybi provides services primarily for the sectors; Chocolate, Sweets, Dairy Products, Bakery Products and Feed Sector.

Kempostar Gıda San. ve Tic. A.Ş., another successful application on this matter in our country, has been founded in 2011, in Salihli County of Manisa in order to produce whey powder transforming whey accepted as waste due to their environmental effects into an industrial product. Kempostar increases its production capacity day by day due to technology it uses in their productions, automation system and modern production plants it owns, and carries on its investments in order to produce new products for food sector. Kempostar supplies raw material daily from contracted suppliers and processes, which it uses in production of whey powder. Kempostar performs physical, chemical and microbiological controls in each stage of production rigorously and operates in hygienic conditions in accordance with international standards. Products produced by Kempostar can be sorted as whey powder, 50% demineralized whey powder, 70% demineralized whey powder and 90% demineralized whey powder.

THE BEST PRACTICAL APPLICATIONS IN POLAND

Maciej Dymacz, Wioletta Czernatowicz

Milk Market in Europe and in Poland.

The **European Union** is a major player in the global dairy market, as a leading exporter of dairy products, especially cheese. Milk production is carried out in all EU Member States and a significant part of the value of EU agricultural production. In some Member States, the dairy sector, forms a very important part of the agricultural economy. In 2011, in the European Union, milk production was approximately 152 million tons. The largest producers are: Germany, France, the United Kingdom, the Netherlands, Italy and **Poland.**

The dairy industry is one of the main lines of agricultural production in Europe. **Milk production in Poland,** which is the world's third largest manufacturer and exporter fifth in the 1980 ÷ 1988 amounted to an average of 15 million m3. In 2003 ÷ 2006 milk production decreased by 3 million m^3, However represented about 2% of world production. Typical Polish dairy pays 450 ÷ 600 m3 / d of wastewater, containing an average of 200 ÷ 700 g O2 / m3 BOD5, up to 3 000 ÷ 5 000 g O2 / m3 BOD5. Wastewater discharge depends on the size of the plant and the type of production.[2]

Milk production

According to Eurostat, **in Poland milk** deliveries in the first half of this year were 1.4% lower than in the same period last year. A similar situation occurred in most Member States. A slight decrease (1.7%) is also visible when comparing the first three months of 2013/2014 quota year to the first quarter of the previous year quota. The volume of supply in the EU has

increased steadily since the beginning of the current calendar year to May, reaching in May, the level of over 12.5 million tonnes. From the middle of the year we observe a decrease in character seasonal (June approx. 12.3 million tonnes). In previous years, the situation was similar - from June to November decreased milk production, while at the end of the year was followed by an increase. Since mid-2009, prices of raw milk in the EU are rising. The weighted average price in the countries of the "old" fifteen in June. Reached more than 36.3 € / 100 kg (compared to 25.1 € / 100 kg in June 2009.). The weighted average price of 100 kg of raw material in the EU-12 was at the same time, € 30.3 (compared to € 21.1 in 2009.). Maintained at about 20% of the price difference between the EU-15 and the "new" countries. For milk produced in June, the best breeders were rewarded with Cyprus (56.8 € / 100 kg), Malta (54.9 € / 100 kg) and Finland (44.2 € / 100 kg). On the other side were: Latvia (29.4 € / 100 kg), Lithuania (28.6 € / 100 kg) and Romania (27.1 € / 100 kg). **Polish producers** in June received an average of 29.5 € per 100 kg of raw material (approx. 126 zł), which placed them on the 24th place in Europe, including for **Hungarians,** Czechs and Slovaks.

Production of liquid whey in Poland and its processing technology.

Systematic increase in the production of cheese, ranging from a few to several percent per year, contributing to the production of the domestic dairy industry huge amounts of liquid whey. Using data about the production of cheess in (2002) estimated the total number of created with the whey for over 2 billion liters. Based on similar calculations can be adopt, in 2006, with increased production and curd cheese ripening,

respectively, to 265 and 302.4 thousand. t (Milk Market, 2007), the volume of whey obtained in **Poland** increased to about 3.35 billion liters. According to various assessments, the total amount of whey obtained **in Poland,** about 70% are rennet. Currently there is no technical and technological problems in the processing of whey of this type, which allows the recovery of the most important elements - especially whey proteins, which during processing of the raw material liquid are not subject to denaturation. At the same time, low pH and high salt content reduce the possibility of acid whey processing, lowering the efficiency of the methods used

Whey processing products - composition, properties, applications in Poland.

Domestic manufacturers now offer two basic forms of anhydrous (less than 95% by dry weight) of sweet whey type, comprising 10-14% protein and 65-75% of lactose whey powder and whey powder partially demineralized. These products are characterized by a low-fat (1%) and the participation of diverse ingredients mineral 9.5 or 5%.

Dairy in POLAND

Production of SMP (skimmed milk powder) in the EU in the first half of this year. Amounted to almost 574 thousand tonnes and was 9.7% lower than in the first six months of 2012. Within three months of the year 2013/2014 quota in the EU produced 308 thousand tonnes of skimmed milk powder. In the same period the previous year quota SMP production totaled 342 thousand pond tonnes (a decrease of approx. 10%).

The leaders of SMP in the Union are the French and Germans, who in the first half of the calendar year produced a

total of almost 400 thousand tons. Poland is one of the major manufacturers (50 thous. Tons in six months). Production WMP (whole milk powder) in the EU in the first half of this year. Amounted to more than 296.8 thousand tons and was 0.9% lower as for the first six months of 2012. Within three months of the year 2013/2014 quota in the EU produced 155.9 thousand tonnes of butter. In the same period the previous year quota butter production amounted to over 144 thousand tons (an increase of approx. 1.7%). The largest producer in the EU market WMP include the Netherlands, Denmark, Germany, and France. Altogether, these countries in the first half of the calendar year produced almost 220 thousand. WMP tons. In the same period in **Poland production** amounted to 15.5 thousand tons.

Export in Europe and in Poland

As mentioned at the beginning of this article, the European Union is the largest exporter of cheese in the world. During the first six months of 2013 years export this product was more than 452 thousand tons. Compared with the first half of the previous year, there was a slight increase in the volume of exports (by 7.3%). To the world's top exporters of cheese are also the United States and New Zealand. Both countries together in the first half of the year exported nearly 360 thousand tons of cheese. Between January and June 2012 years the volume of exports of SMP from the EU amounted to more than 343.9 thousand tons. In the first half of 2014, the EU exported 239.2 thousand tons (down 30.5%). The decrease in the volume of exports from the EU and US growth has meant that for the first place in the period put forward by the United States. Leader for exports WMP is New Zealand. In the first half of the year,

export volume reached 706.1 thousand tons. For comparison, WMP exports from the EU-27 in the same period amounted to 216.9 thousand tons. In the same period the previous year, exports of this product from the EU amounted to 243.5 thousand tonnes (a decrease of 10.9%).

Enrichment of probiotic cheese.

Rennet cheese ripening and cheese acidic media can be valuable probiotic strains. Their weight is an excellent buffer for cell protection against low acidity probiotics environment of the gastrointestinal tract, and thus creates favorable conditions for the survival of their cells during passage through the digestive system. However, because of the quality requirements and minimum therapeutic, for use of probiotic strains in the production of

cheese it is necessary to modify the manufacturing process and / or some of its parameters, in order to enable bacterial cells to survive in the product until the last day shelf life. On the other hand, the cheese with the addition of probiotics should have the same quality as conventional cheese, so the inclusion of probiotic strains should not cause deterioration of the taste, texture, durability and appearance. There are two variants of the probiotic cultures of the additive during the production process of cheese, which can have a direct impact on the survival of microorganisms in the final product: a) prior to the fermentation and the coagulation of milk protein, or with cheesecloth culture technology and other additives, b) after fermentation and after clot formation of coagulated milk proteins. **On the Polish market** there are only a few rennet cheese ripening or acidic with probiotics, ie. For example. Lactobacillus acidophilus La-5, Lactobacillus acidophilus

NCFM, Bifidobacterium animalis subsp. lactis Bb-12, Bifidobacterium animalis subsp. lactis HN019, Lactobacillus paracasei CRL 431.

Increasing the mineral content.

In the dairy industry, "fashionable" minerals are calcium and magnesium. Both of these minerals compete for assimilation in the intestines, which should suggest that food supplements should take into account the addition of these two elements so that the increased supply of one of them did not cause shortages second. Considering the production technology of acid or rennet cheese ripening enriched in calcium or magnesium, examine many aspects. Firstly, at which stage of the production of milk salts of these elements will be added and in what form. There are many calcium and magnesium salts, which differ in smell and taste (which can alter the taste and aroma of the final product) of the aluminum elemental solubility in water, and the effect on milk protein. Not to mention the cost of these salts.

Add value of whey products.

The increasing interest of scientists recently also raise discovered antioxidant properties of individual fractions of whey protein. There are quite a reasonable suspicion that the consumption of whey protein has a direct impact on overall health, vitality and delaying the effects of aging. Formulations containing the whey proteins are also successfully used in anticancer therapies. Anti-cancer properties are directly attributed to cysteine and methionine, the amino acids present in the composition of whey protein.

General characteristics of the wastewater and the sources of their formation in Poland.[4]

With the amount of discharged wastewater combined unit water consumption, which depends on the size and nature of the dairy production. Consumption of water in the catchment averaged 0.3 ÷ 0.5 m3 / m3 of milk and 5 to 15 m3 / m3 in dairy plants. The wastewater from production, dairy arise mainly in the process of washing and rinsing. Their main pollutants are organic substances such as residual milk, whey and fat. The wastewater produced milk catchments as a result of washing dishes, equipment and tanks, which the milk is transported. Diluted waste water, containing substances washing. In dairy milk is transported wires that are periodically washed chemical substances acidic or alkaline cleansing? These preparations are known under various trade names such as:

MANUREN alkaline (> 30% sodium carbonate + 5 ÷ 15% disodium metasilicate, pH 10 in a 1% solution)

FAL acid (20 to 70% ACIDAN CIP acid (> 60% phosphoric acid + <5% nonionic surfactants, pH 1.9 in a 1% solution), acid P-3 - Ultrasil 110 (1 ÷ 5% sodium hydroxide + 15 ÷ 30% etylenodiamonitetraoctowy + 1 ÷ 5% alkilobenzylosulfonian) and others.

Dairy industry wastewater are readily fermented, which results in a substantial reduction of pH (up to 4.5) and a heavy consumption of oxygen in the waters of the receiver. Organic substances are readily biodegradable and are a good medium for the growth of microorganisms and fungi sludge, fouling the banks and the formation of bottom sediments. Therefore, the dairy industry wastewater before discharge into the receiver, should be subjected to a process of purification.

Methods of dairy wastewater

For wastewater treatment are used dairy industry Various methods:

• Irrigation of fields and meadows, by fissuring and spread irrigation.

• Circular ditches are used for 60 years

• Systems of wastewater treatment plants with activated sludge may include:

• single-treatment, two-stage treatment of biosorption and bio stabilization, three-treatment, using chemical polishing and treatment multiphase

• Wastewater treatment SBR (Sequential Biological Reactors). Cleaning and fractionation of the organic components contained in the wastewater and whey membrane methods

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Best practices in Poland

The **A-Lima-Bis Ltd.** company has been operating for over twenty years. During those years they have been focused on production and delivery of machinery and equipment for dairy farms and industry including equipment for milk collecting, storage and processing. Moreover, the company is the main supplier of membrane systems and technology for many industrial branches and a producer of high quality whey powder. Additionally, the company owns the production facility that is intensely developed and supported by highly qualified technical and engineering as well as research and planning staff. One of the lines of action of A-Lima-Bis is production of whey powder. By-product of the production of each type of cheese, regardless of the technology conducted clotting is whey. It contains 50 to 60% of the dry weight of the ingredients used in the production of milk. To pass from the milk whey medium:

95% albumin
95% of globulins
33% casein
96% lactose
8% of fats

81% of the minerals
The offer:
- Demineralized whey-Technical Specifications: zdemineralizowana.pdf
- Whey simple - Technical Specifications: zwykla.pdf

Whey powder is used in many sectors of the food industry where it replaces milk powder. It is used as animal feed manufacturers.
- Production of bread
- Production of cakes and pastries-manufacturing chocolate and sweets-processed cheese
- A mixture of milk powder
- Production of feed and milk substitutes

The primary objective posed in the production of whey powder is to provide a high and consistent quality of the finished product. Company A-Lima-Bis achieves this goal by:
- A detailed inspection of raw materials
- Audits of suppliers of raw materials and auxiliary materials
- Use in the production of health security system according to HACCP
- Continuous monitoring of all process parameters
- Conduct ongoing monitoring laboratory (chemical and microbiological) at each stage of production

All these measures lead ultimately to obtain whey powder with a very good and consistent quality.

EWAN Import-Export is an organization functioning in the food sector on the Polish market since 1998. The business is based on the wholesale distribution of raw materials for confectionery products. The offer is the best products of leading Polish producers of the dairy industry. In EWAN Import-Export combine many years of experience with innovative technological processes, so our customers are guaranteed the highest quality products that meet their requirements and needs. EWAN also provides quick delivery and competitive prices, as well as professional and competent customer service. In addition, EWAN offers delivery of goods adapted to the customer how forwarding.

The offer EWAN Import-Export include whole milk powder, skimmed milk powder, whey powder, cream powder, butter and cocoa powder, and recently also fiber cocoa.

WHEY POWDER

Colour - creamy yellow

- Appearance - powder free flowing, uniform, allowed a slight agglomeration, easily crumbling
- Colour - white to light cream, with no burns, uniform
- Mechanical impurities - no, allows particles burnt by the pattern A, B
- Fat - max 1,5%
- protein - min 11,0%
- Lactose - 72%
- ash - max 8,5%
- Water - max 4%
- Hard - max B
- pH - min 6%
- Antibiotics - absent
- All large microorganisms - max 10.000 / g
- Coli bacteria - absent in 0.1g
- Yeasts and Moulds - and no signs of mildew
- Salmonella - absent in 25g
- Taste and smell - kind without foreign tastes and odors
- The presence of pests and their residues – no

THE BEST PRACTICAL APPLICATIONS IN ITALY

Levi Bettin, Dalmar Mohamed Ali, Bernd Faas-Italy

The molise experience of recycling the liquid whey for feeding animals

The molise experience of animals recycling the liquid whey for feeding

The dairy industry is associated with the production of wastewaters and effluents that could have a significant environmental impact because of their pollutant characteristics. The dairy waste that is receiving considerable attention is cheese whey, since approximately 1 kg cheese produces 10 L cheese whey. In Italy, the cheese production in 2013 was 1.157.740 ton while the world production of cheese whey is estimated to be over 108 tons per year. Thanks to its high

nutritional value, liquid whey can be recycled within the dairy chain for feeding animals. Following the LCA methodology, animal diets including or not liquid whey were assessed and compared in a study conducted by researchers of the University of Molise that refers the environmental analysis to a sample of dairy farms located in inner areas of Molise region, Centre Italy.Despite the small size of the region, the local cheese production contributes approximately to 1.8% of the national cheese production and has a strong traditional character.

The environmental impact assessment has been carried out by comparing three farms where Italian Friesian dairy cows are raised following feeding strategies summarized as: farm A, traditional feeding, i.e. hay and no liquid whey; farm B, including silages but no liquid whey; farm C including both silages and liquid whey. The considered system was defined by whole life cycle of cows (from birth and growth, to milk production) including the agricultural processes of feedstuffs.

The liquid cheese whey, produced by “L. Barone snc”, was used in animal feeding as partial substitute of drinking water. All the system was consistent with the perspective “from a cradle-to-gate”. The functional unit (FU) was “1 kg of energy corrected milk (ECM) at the farm gate” in order to consider the fat and protein contents of the milk. The mass allocation was

previously used to share the environmental burden between milk and meat, then compared with a cereal unit allocation.

The method ReCipe Endpoint (H)/ Europe 1.09 was used. Weighing and characterization among farm units have been carried out to identify the farm with the highest impact and the main categories of impact at the "endpoint" and "midpoint" levels. The analysis of the environmental impact of milk production at "endpoint" level showed that farm A, was more impacting than farms B and C, mainly due to management of diets.

The same results were achieved in the cereal unit allocation, even if the mass allocation results were higher than those with cereal unit allocation. The use of commercial mixed feeds had the largest impact on all farms mainly as a consequence of soybean cultivation (an ingredient of mixed feeds). Moreover, in all the farms the main damaged category was the ecosystem. The characterization phase allocates the environmental impacts to the "midpoint" categories. The farm C showed a global best environmental performance, because its impacts account on average for about 86% of the impacts attributable to farm A. This means that switching from a case

with hay and no liquid whey (farm A) to a diet including both feedstuffs (farm C) would result in a decreasing environmental impact. Comparing the farms for each impact category, farm A has a higher impact than farms B and C on all categories except on PMF and TA categories. The impact on PMF category was mainly caused by ammonia from forage cultivation for hay (farm A) and from grass cultivation for silage (farms B and C).

The impacts of farms A and B on PMF category were similar in size (98 % vs 100%): that is because farm A included hay in rations and had the lowest daily milk yield, while farm B used silage in rations and had a higher daily milk yield. The differences between the PMF impact of farms B and C were due to the daily yield (respectively 28 L and 29 L). The highest impact on TA category was observed in farm B, where it was due to the ammonia from grass cultivation for silage, followed by farm C.

Considering the impacts in absolute terms, among "midpoint level" categories belonging to human health, the highest impact is on CCHH category and it is due to the carbon dioxide caused by tractor fuel combustion in soybean cultivation (an ingredient of mixed feeds). This component of mixed feed was present in the diets of all farms, but the differences among their CCHH impact were mainly due to the different daily milk yield. As far as the PMF category, as above, absolute impacts derived mainly from ammonia. The impacts on HT category were caused by manganese coming from cereals cultivation. Among "midpoint level" categories belonging to ecosystems, the highest impact was on ALO, followed by CCE categories.

The soybean cultivation causes, for all farms, the above mentioned impact on ALO category. The impacts on CCE category were caused by carbon dioxide coming from tractor fuel combustion for soybean cultivation. Finally, between the two "midpoint level" categories belonging to resources the highest impact is on FD category due to crude oil from fuel consumption, used for soybean cultivation (all diets).

In conclusion, farm C showed the least environmental impact due to cow's diet (including both silages and liquid whey) and milk yield per cow (29 L vs 28 L of farm B and 25.1 L of farm A), confirming that impacts decrease at increasing milk yields. Using the LCA methodology, the study assessed the environmental impact of milk production when liquid whey is introduced in balanced dairy cow rations partially substituting drinking water. The results, although on a limited number of dairy farms, show that farm C, with both silages and liquid whey use, is the least impacting. This finding is mainly due to the different diet that increase the milk yield when the silages and the liquid whey are included. The best environmental performance of farm C compared to other farms suggests that the best feeding strategy consists in using silages and liquid whey in dairy rations.

Intensifying the recycle of liquid whey and strengthening the relation at local level between cheese industries and dairy farms, the cost of whey transport could be reduced and the disposal costs of liquid whey would be eliminated, with positive environmental effects.

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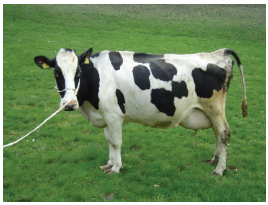
Use of whey for cow feeding in cheese short supply chain under LCA

A similar kind of application for liquid whey is reported on a case study in Umbria related to the production of a cheese specialty made with cow milk flavoured with saffron from Cascia, called "Oro di Cascia" (Gold of Cascia) produced in the surroundings of the famous medieval town in Umbria, by the "**Opagna farm**".

The "OPAGNA FARM", situated in the locality Opagna of Cascia (PG),located in Opagna, near Cascia, in a mountainous area at about 1200 m. s.l.m., is family run and has a total area of 70 hectares, of which about 65 arable land, distributed as follows:4 ha of barley, 2 ha of wheat, 2 ha of rye, 2 ha of spelt,20 ha of alfalfa, 33 ha of meadow-pasture. The company, in addition to property land, also has access to about 130 hectares of natural grassland for rent by the agrarian community of Opagna, used between May and October for the pastures of heifers and dry cows. At the farm are bred dairy cows of different breeds (Italian Friesian, Italian Red Pied and Brown Italian), for a total of 60 cattle.



The animals during the winter and in the warmer summer days are kept in the shed. The average daily milk production per cow is about 20 kg.The environmental best practice consists of a close production circle with use of liquid whey as an integrator of the sheep ration. The complete process, from crops and breeding to cheese production and commercialisation, is managed under LCA procedure so that the environmental impact can be controlled and limited.



The cheese produced by the "Farm of Opagna", flavoured with saffron, as in the tradition from XVII century is obtained from cow's milk coagulation of two milkings, that made in the evening and that in the morning. The milk milked in the evening is left to stand at a temperature of about 4°C and the morning after is mixed with the fresh milk to an extent of 50%. Once transferred the milk in the dairy boiler, pure saffron of Casci is added and the whole is put to stand for about thirty minutes, then the milk is heated to a temperature of 37-38 ° C (raw milk processing) and when the liquid mass has reached this temperature the rennet is added and the mass

shaken energetically so that this enzyme is evenly distributed in the milk. The milk clotting time is about forty minutes, after which there is the breaking of the curd in numerous parts of the size of a walnut through the use of a thorn. Once broken the curds, the cheese mass is left to stand another twenty minutes for the further densification of the paste and the whey.After this time, the cheese mass is transferred into molds which give the cheese its characteristic rounded shape and which are subsequently placed in a vessel wherein the step of steaming is carried out. The stewing is an operation of heating the cheese with steam at 40 ° C for 4 cycles at a distance of a half hour from one another, which allows the final clearing of the serum. After the phase of stewing the cheese is left to stand for 12 hours before they faced the salting, which takes place in brine.

The hard brine takes just a little more than two hours, given the small size of the forms of cheese saffron (weighing about 0.5 kg). After this short time the product is transferred to the chilling room where it undergoes a maturation process of about 20 days, after which begins the commercialization. The company produces exclusively raw milk cheese, a characteristic that gives a considerable added value to all dairy products put on the market. In fact, the cheese at 37-38 ° C allows the preservation of aromas, taken from the animal with the grazing, and the microflora of the milk, which are then transferred into the cheese resulting in a product which has the organoleptic characteristics of a superior quality dairy product As said, all the process is strictly controlled under Life Cycle Assessment, as well as, obviously HACCP procedures. A particular care is paid to use always fresh whey for the ration of the cows. This close short cycle enables the farm to use internally all the whey and integrate animal feeding. The dairy

building is just 300 mt. from the stables, so the fuel necessary to transport milk is very limited.

Flow-Diagram of Oro di Cascia cheese making

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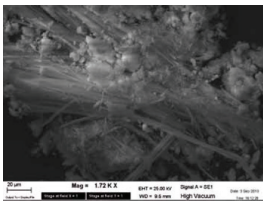
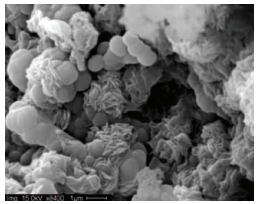
Patent on use of liquid whey to destroy asbestos fibres

The **Chemical Centre srl** Structural Environmental and Biological Chemistry (LEBSC), belonging to the Bologna University Department of Chemistry, has registered an invention patent on process to obtain geo-mimetic fibres from asbestos, that is in this case separated from other than silicon and magnesium. Researchers in their activities at the Chemical Center Srl , using their specific experiences in the field of nanotechnology acquired in basic research on materials so called “biomimetic” and “geomimetic” . The biomimetic materials are synthetic materials that mime composition, structure, morphology, surface reactivity and many other chemical-physical characteristics of the natural biological materials. Among the geomimetic materials, namely those that are synthesized with chemical-physical characteristics copying natural geological materials, the asbestos fibers represent surely the most interesting example. The researchers of LEBSC have published their studies on asbestos in dozens of international scientific magazines. Since 2002 they developed a method of synthesis enabling to prepare in laboratory synthetic fibres. The patent of Chemical Center Srl, describes a process capable of transform the asbestos fibres rendering them inert and reusable in the production cycle structure, morphology, surface reactivity

and many other chemical-physical characteristics of the natural biological materials. Using nanotechnology is possible to synthesize a geomimetic asbestos with the same structure and morphology of the natural, but non-toxic, and then with high application potential in technology . The study demonstrated that this bio-technological process, allow to separate asbestos from iron, nichel and manganese and denature and completely destroy the fibres. The patent EP2428254B1 describes a bio-technological process of destruction of asbestos fibres, such as for eternit artefatcs, by using **hot liquid whey** (180°C), and i) dissolution of the cement component and ii) complete denaturation of asbestos fibres. **This recent invention is under trial involving dairies, including one located in Umbria, to test the process on eternit roof coverings**.





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Research project on use of whey and other by-products for biogas

BYPRO-ENERGY is a research project funded under the Rural Development Plan 2007-2013 of Region Umbria, Measure 124. The main project objectives, in the framework of the July 6, 2012 Ministry Decree, are:

• to make sustainable the development of renewable energy sources by using wastes, effluents and residues from agriculture and food industry and demonstrating in this way their values as by-products;

• to use by-products as residues from agro-industry productions to replace partly or completely energy crops, grabbing arable land to food production, and verify the related physical-chemical parameters for biogas production from different mixtures of by-products;

• to evaluate the weight in terms of economic and environmental sustainability of this kind of substitutive by-products in comparison with bio-energy crops, by applying methodologies such as Life Cycle Assessment and Life Cycle Costs;

• to determine certification guidelines for this kind of bio-energy supply chain model and set a feasible system improving performances and environmental sustainability of the agro-energy sector;

• to develop a network at local and inter-regional level of farms for optimal management, use and best practices of by-products for energy purpose.

The partners of the research project are:

• University of Perugia (UNIPG) – Department of Civil and Environmental Engineering, responsible for project coordination, monitoring chemical-biological anaerobic digestion in biogas and composting and Analysis of the Life Cycle (LCA) and Cycle Cost (LCC);

• AIEL – Italian Association for Agricultural and Forest Energies, responsible for technical monitoring of biogas systems management and development and validation of the checklist with draft guidelines for improving environmental performances;

• CIA Umbria Services to Enterprise Ltd. , responsible for coordination and technical support of companies for the provision of products and by-products to biogas plants and support to fulfillment of regulations;

• 3A-Agri-Food Technological Park Ltd. Coop. (3A-PTA) responsible for dissemination of ongoing and final results; and five farms and a cooperative producing biomass (Agricola Trevi Coop. , Az. Agr. Pambuffetti, Az. Agr. Antano, Az. Agr. Priori, Az. Calcabrina) and two farms testing the anaerobic treatments of by-product mixtures (Agrienergia Pietrarossa and Agr. Pambuffetti).

Figure 7 - BYPRO-ENERGY Project - Biogas Plant at Agricola Trevi Coop.

Materials and Methods

The first part of the project consists in an experimental phase that includes all the chemical-physical analysis of the case and the laboratory tests batch (tests of anaerobic digestion) to test the potential methane-making mixtures before being used in the plant test. These activities are leaded by UNIPG, more specifically by the Department of Agricultural and Environmental Sciences and the Department of Industrial Engineering. A sample of products and by-products to be tested as organic mixtures for producing biogas has been: Sewage+Corn+Marc(Grape Residues) Sewage+Corn+OliveResidues (incorporating and adding olive mill residues)Sewage+Corn +Whey Sewage+Corn+Whey+Marc+Olive residues (incorporating and adding olive mill residues) Sewage+Whey+Marc+Olive Residues (incorporating and adding olive mill residues) The amounts in percentage of each product and by-product are

determined following the chemical-physical analysis carried out on a matrix based on the various combination of mixtures for optimal production of biogas.

In particular, are investigated the following determinations: moisture, volatile solids, specific gravity, pH, total organic C, total N and ammonia, total P, total K, C / N, C / P, C / K, NDF, NDADF, ADL, CS, cellulose , emicellulose- Methods APHA [1], 1998; CNR IRSA Method [2], 1994; Method Van Soest et al., 1991 [3]) on starting matrix (liquid manure, corn, whey, marc and olive residues).

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THE BEST PRACTICAL APPLICATIONS IN HUNGARY

The particular production os dairy products and whey and their consuming up in Hungary. The functioning os BOPPE Ltd.

Dr. Imre Mucsi-Hungary

Milk produced by milk producers is suitable for milk process, in case the total number of germs and static sell numbers is low, at the temperature of 4 degrees. Different kinds of dairy products can be produced from milk with fat content set in the proper way.

Curd is a white product consisting of soft clods of curdled milk. The basic material of curd is milk. During the home-made procedure the milk is left to curdle first, then it is warmed up and the curdy clot is put in linen cloth or gauze and hung up to fall down in drops. When whey has fallen down in drops only fresh curd is left in the cloth.It must not be boiled because in that case the curd will be bad and dry. It can only be heated up at the degree of maximum 60 degrees. At last it has to be left in order to cool down.

During large scale production curd is made from pasteurized skimmed milk, it is left to drop down without pressing in order to keep its moisture. Its fat content is between 0,5-12%. Most of the whey can be removed with the help of filtration and the curd produced in this way is drier and more crumby. The curd and the whey have a little bit sourish taste. After filtering it consists of soft, white pieces and it can be processed in many ways. Curd is made from the milk of cow, sheep and goat.

The process with the needs of the highest special knowledge is cheese production.

Cheese production needs milk curdled in the quickest possible way and a process completed in 20-60 minutes, it should not get sour: it stays sweet with milk-taste. During cheese production a considerable quantity of sweet way is gained from which more and more subsidiary products can be made.

Ricotta is a creamy, sweet milk product, but it is not curd. The base of ricotta is the sweet whey that stays behind during cheese production and after heating and filtering ricotta is gained.

Whey protein is another way of making use of whey during the process of making cheese from milk. Whey and products made from it have usually got a pleasant taste, but it is true that, in the case of many products, it is the result of giving a considerable amount of sweetener to it.

Whey concentrate has a high content of protein which, depending on its type can also be 29-85%, but the cleanest isolates can approach to 90%. The profile of amino acid is complete, it has one of the highest biological value. There is a great choice of flavors and executions which can be attained in wide range. In Hungary we can buy at least one hundred variations, it can be obtained in every training rooms so it is no wonder that most of the body-builders start taking this.

The special feature of milk and dairy product consumption in Hungary is the relatively high level of sour cream and curd consumption. More and more yoghurt, kephyr, ricotta, soft, semi-hard and hard types of cheese is produced and consumed.

Producing cheese from the milk of small ruminant and lactiferous animals (sheep, goat) is restricted mostly to minor and medium-sized plants.

There are more and more methods for the application of whey protein. Food-processing industries, such as bakeries, sportsmen, sportswomen and body-builders, needs a considerable amount of it. the quantity that is left even beyond this is put in animal food or is given to pigs in the form of liquids.

B O P P E LTD:

A fifty-animal milk producing dairy-farm was established in 1991 in Hódmezővásárhely at the Faculty of Animal Husbandry of the University of Agriculture of Debrecen with the support of the Dutch Government. The Dutch-type plant with the size of a farm started working in 1993.

the Dutch partner demanded the Faculty to run the plant completely independently from the institution thus proving that an enterprise like this can manage successfully even within the Hungarian economic conditions. So the Faculty let the units for rent. The dairy-farm was taken by a private person and the milk processing plant by BOPPE BT. In the mean-time the institution was attached to the University of sciences of Szeged working as its Faculty of Agriculture at present. The firm buys milk from the Dutch milk producing plant and a nearby agricultural farm.

"BOPPE Ltd. was established in 1993. in Hódmezővásárhely with the support of the Dutch Government. Our main profile is producing dairy products. It means the producing of different soured dairy products,, curd and various kinds of cheeses.

During the production procedure we use the HACCP system according to the legislation both of the EU and the national one.

The strong point of our enterprise is that we are flexible in compliance with the needs of our customers and the market. During the production process with the traditional technologies we use as few additives as possible and also only the inevitably needed ones.. our products are plain yoghurt and its fruity variations, for example sour-cherry and bilberry-flavored yoghurt. Besides these we produce sour-cream, semi-fat curd and semi-hard Gouda and Maasdammer cheese. During the production process we strictly stick to the principle of producing all our products exclusively of milk. We do not use any kinds of "repairing" materials. we use traditional small-scale production. We turn over cheeses every day actually taking each of them in hand and so we can notice at once if there is any problem during the period of aging. In a certain

sense this ensures a kind of individuality to our products. We introduced basically Dutch technology. We bought the basic machinery in the Netherlands and we also enlarged it during the years, but the production technology itself is that of the original Dutch small-scale milk processing technology. That is why our products have a particular quality on the national market. Even in hard times of the whole branch BOPPE Ltd. had dairy products which sold well on the market."

The products are sold to confectionaries, shops and in a small amount directly to citizens in Budapest and its surroundings, in Szeged and in Hódmezővásárhely. Whey produced during cheese and curd production is made use of by bakers and those producing confectionary products. Surplus whey is made use of as fluids by pig-breeders.

The firm takes over the following quantity of milk from dairy-farms and produces consumable milk, dairy-products (sweet-cream, yoghurt,curd, cheese and whey):

The quantity of processed milk and dairy products in years 2010-2015

Year	2010	2011	2012	2013	2014	2015
Processed milk (litre)	815,020	835,090	804,038	693,885	733,504	624,119
Pasteurized milk (litre)	183,257	197,770	229,890	176,340	151,520	193,770
(Sweet) cream (litre)	38,920	40,280	36,890	33,930	32,650	29,570
Yoghurt (litre)	41,680	45,920	47,170	42,740	38,700	36,070
Semi-hard curd (kg)	14,229	17,770	21,450	20,790	27,320	13,510
Semi-hard cheese (kg)	70,470	68,240	54,480	47,510	44,210	43,120
Whey (litre)	130,403	131,510	120,420	111,020	117,360	99,860

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11. ITALIAN DAIRY PRODUCTION AND MARKET

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The dairy sector is the first Italian food division, with a sale of 14,2 billion of euro. The weight of Italian dairy sector in terms of agriculture gross domestic product (GDP about) is around the 10%. 75% of the milk is produced in the North districts of Italy: Lombardia, Emilia Romagna, Veneto e Piemonte. In Italy 11 millions of tons of milk are produced and 13 millions of tons of milk are converted in 1 millions of tons of cheeses (more than 440.000 tons are PDO cheeses), almost 3 millions of tons of pasteurized drinking milk (1.300.000 tons) and UHT milk (1.600.000 tons) and 190.000 tons of yogurts and fermented milks. The cow milk production in Italy is 10.5 million of tons (52% of self- sufficient) and this quota is the 7% of total amount of the EU milk production. The Italian dairy herds structure radically change in the last decades and the most important aspects of this change were the progressive concentration and specialization of dairy herds.The number of dairy cows, in the last 20 years, are reduced more than 65% and in the sameperiod the average herd size is almost tripled (28.84 cows/herds).

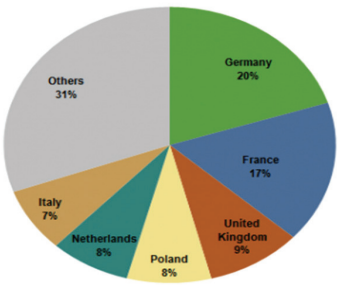

Figure 1 - Source EUROSTAT – 2011.

Also to be considered in this change is the effect of the milk quotas in Europe, with restrictiverules for the producers. Average milk yield production per cow is 6,010 kg and it is comparable with other EU countries, but above the levels of other Mediterranean countries. The peculiarity of Italian milk production is the high quota of fluid milk used for cheese making (68% of total domestic milk yield). The 80% of cheese manufacture is of varieties that are exclusive to the localities from they come and that cannot therefore be made outside those areas (e.g. Parmigiano Reggiano and Grana Padano). A weak point of Italian dairy industry the extremely fragmented structure with almost 70% of Italian cheese output produced by enterprise handling less than 4,000 tonnes of milk per year. This high fragmentation can be changed into a competitive advantage if Italian dairy industries will invest on typical, traditional and local dairy products.

Italian dairy industry produces a great variety of traditional cheeses (see Figure 2), all of them unique in their organoleptic and nutritional characteristics and processing technique: Mozzarella occupies the first place as far as volume is concerned (250,000 tons/year), followed by the two most

popular PDO (Protected Denomination of Origin) cheeses in the world: Grana Padano, the most exported with 163,000 tons/year, Parmigiano Reggiano, the most imitated with 116,000 tons/year, Gorgonzola, Pecorino, Asiago, Taleggio, also part of the Italian traditional cheeses.

Main Italian cheese productions (tons)	
Mozzarella	275.000
Grana Padano	158.300
Parmigiano Reggiano	113.500
Gorgonzola	47.700
Pecorino Romano	26.700
Provolone	26.700
Asiago	23.500
Taleggio	8.500

Figure 2 – Source International Dairy Federation – Main Italian Cheese Productions

Figure 3 – Source International Dairy Federation – Main Destinations of Italian Cheeses

The 2011-2014 economic recession further depleting the purchasing power of the majority ofItalian consumers, a trend which had a major negative impact on sales of cheese. This negative trend was partly balanced by cheese export in other European countries, Italy exports almost 250.000 tons of cheese, with a value of 1,4 billions of euro. Main Italian exported cheeses are Mozzarella and other fresh cheeses (36,4%), Grana Padano PDO e Parmigiano Reggiano PDO (25%), Pecorino Romano PDO, Gorgonzola PDO and Provolone.

Italy's prolonged economic recession continued to erode the purchasing power of the majorityof Italian households during 2014, resulting in a subsequent contraction in expenditure. This led to cheese recording further declines in foodservice volume, retail volume and retail value terms, while the retail distribution of cheese continued to shift away

from traditional grocery retailers outlets towards chained modern grocery retailers outlets. In drinking milk products, manufacturers suffer from the ongoing decline in disposable income levels and purchasing power among the majority of the Italian population as demand shifted towards low-priced brands and private label, with sales of premium brands and other high-priced products falling.

Yoghurt and sour milk products also suffered declines because of the more intense competition coming from other packaged food categories such as ice cream and other dairy-based desserts. So called other dairy products, mostly including milk based snaks, have a different trend in comparison with cheese and drinking milk products or yoghurt, since the majority of Italians continued to reduce spending on dining out as a way of saving money, staying at home for lunch and dinner and taking lunchboxes to work. As a result of this, certain other dairy categories generated positive retail volume and value growth during 2014. The whole dairy division in Italy is expected to register lightly better performances over the forecast period, increasing in 2015 for around 1% in constant 2014 value terms.

Overview on milk-cheese production in Italy

The dairy industry is articulated in the production of pasteurized milk and sterile, butter, cream, fermented milk, condensed and concentrated and cheese (fresh, seasoned, cooked, etc.). About 60% of the milk produced in Italy is intended for processing into dairy products. This production sector is clearly differentiated between large and medium enterprises on the one hand and cooperative dairies in size craft and residual small units attached to other farms. Most

medium and large industries operating in the food and milk in the production of fresh cheese consumer, while small businesses and cooperative enterprises are mainly engaged in the production of typical and quality semi-hard or hard cheeses of (such as Parmesan cheese, Grana Padano, etc.).

The national dairy production, unlike that of the countries of northern Europe, is characterized by a high number of processing plants. By ISTAT (Italian statistics agency), Italy count about 2,000 cheese plants, which turned over 9 million tonnes of milk. Veneto, Campania, Lombardy and Emilia-Romagna are the Italian regions with the largest number of production units. In the southern area the largest number of plants is concentrated in Campania and Puglia; in these two regions, in fact, are located about 64% of the total plants in the South and increasingly these two regions have registered the first and third national presence of dairies and milk plants, with 214 and 137 plants respectively (from ISTAT data). It appears obvious that in the Italian production have particular importance especially hard cheeses (parmesan and between these and the various types of grain), followed by fresh ones (among all the mozzarella), which together constitute more than 70% of the entire dairy production. Looking at the main categories of typical Italian cheeses, it is noted that the yields by weight of the process (mature cheese / milk used) equivalent to an average of 7-8% for the Parmigiano Reggiano and Grana, to 12- 13% for provoloni , 5-6% for cheese like pecorino, to 10% for the Asiago and Gorgonzola and 8% for mozzarella and other kinds of fresh cheese.

Dairy production and effluents in Italy

The liquid effluents that most frequently occur for the process of butter making process are the

following:

• washing water from containers for the storage and pasteurization of milk and cream;

• washing water from containers for butter kneading;

• water used in degasifiers, cells cooling and conditioning of the warehouses;

• water used at the end of the working day for cleaning rooms and external parts of the

• machinery

• For the cheese making process the following types of wastewater (see Figure 6) originate:

• washing water from containers for the coagulation of milk;

• curd cleaning, whose quantitative and qualitative characteristics vary according to the

• type of cheese produced;

• exhausted pickle water from salting;

• water used for cell cooling and conditioning of the warehouses;

• water used at the end of the working day for cleaning rooms and external parts of the

• machinery.

A study conducted in a facility that produces Parmigiano-reggiano allowed to estimate consumption water of between 0.12 0.19 m3 per 100 kg of milk processed, effluents produced had a COD of 1000 to 1400 mg L-1 and a BOD of 600-850 mg L-1 (Paris, 1998). The amount of whey and other effluents produced in the cheesemaking process can be estimated from the amount of milk processed and the consumption of water, or by reference to the total amount of cheese product.

Figure 4 – Chese making waste water and whey (Grana Padano)

Whey processing by-products in Italy

The total quantity of obtained whey in Italy, considering a number of main products amounted to 1,023,811 t per year, was estimated at 6.092 million tonnes per year. It is estimated 362,000 t per year the amount of this by-product sent to the preparation of cottage cheese (ricotta) which are generated, with a factor of cottage cheese production equal to 19,06 kg

t-1, about 345,000 tonnes per year. It is quantified in about 2 million tonnes per year, the whey used for the production of lactose and whey powder. Consequently, the quantities of this product destined for animal husbandry and breeding amounted to about 3.73 million tonnes per year, rising to about 4.075 million t per year if you include the rest of whey from the cottage cheese. Buttermilk, referred to a cheese production amounted to 255 200 tonnes per year, results in a quantity byproduct of about 331 800 tonnes per year. Taking into consideration the production of butter, in reference to a national production equal to 145,000 t, the estimation of the buttermilk production amounts to 11,600 t per year. Since no data are available on the reuse of buttermilk for feeding of pigs, for the extraction of casein and a series of valuable substances for the pharmaceutical industry, it is not possible to estimate the amount destined to waste disposal. As mentioned above, the outgoing materials that in addition to the main production are originated by the industry of cheese are effluents and by-products of manufacturing processes, mainly whey and buttermilk. Their chemical-physical and microbiological characteristics are extremely variable, especially in relation to the type of product and size of the industry.

Best practices for dairy by-products uses in Italy

The most noble part of whey is constituted of proteins extracted from the liquid whey, obtained

during the cheese making process. Whey can be processed into more concentrated forms as proteins, that are mostly requested by the food and pharmaceutical sector for dietary, cosmetic and nutraceutical products for their healthy and antiaging benefits. As a by-product whey contains higher

amounts of protein than other natural ingredients used as food integrators, so its use is increasing in the food sector. Most of the whey sold today for this purpose is dry sweet whey with a composition of about 12% protein, 73% lactose, 1% fat, 4% moisture and 8.5% ash. Whey is largely used as animal feed integrator, but also deproteinized whey, also called permeate, is mostly sold for animal feed, which has turned out to be a good outlet for using large volumes of permeate. Permeate contains primarily non-protein nitrogen compounds and, since seventy five percent of permeate is lactose, the functionality of permeate is really dictated by the lactose content and promoted as "whey and lactose replacer". Also liquid whey is experimented as a best practice of whey re-use, such as in the case study from collaboration between University of Molise and the company "L. Barone s.n.c.". In this case the positive environmental and milk production effects on traditional Podolica race cows, have been tested by substituting drinking water with liquid whey in a balanced cow nutrition and analysing the results "from a cradle-to-gate" under Life Cycle Assessment (LCA). A similar kind of application for liquid whey is reported on a case study in Umbria related to the production of a cheese specialty made with cow milk flavoured with saffron from Cascia, called "Oro di Cascia" (Gold of Cascia) produced in the surroundings of the famous medieval town in Umbria, by the "Opagna farm". The environmental best practice consists of a close production circle with use of liquid whey as an integrator of the sheep ration. The complete process, from crops and breeding to cheese production and commercialisation, is managed under LCA procedure so that the environmental impact can be controlled and limited.

Two very interesting best practices are based in two different and innovative processes to reduce environmental impact of whey and turn it at the same time to useful and economic scopes. The Chemical Centre srl Structural Environmental and Biological Chemistry, belonging to the Bologna University Department of Chemistry, has registered an invention patent on process to obtain geo-mimetic fibres from asbestos, that is in this case separated from other than silicon and magnesium. The study demonstrated that this bio-technological process, allow to separate asbestos from iron, nichel and manganese and denature and completely destroy the fibres. The patent EP2428254B1 describes a bio-technological process of destruction of asbestos fibres, such as for eternit artefatcs, by using hot liquid whey (180°C), and i) dissolution of the cement component and ii) complete denaturation of asbestos fibres. This recent invention is under trial in some farms, including one located in Umbria, to test the process on eternit roof coverings. The University of Perugia, Department of Civil and Environmental Engineering, has leaded a research project based on use of liquid whey as an ingredient of a moisture for biogas production. The project was performed between 2013 and 2015 and the results were recently published. Cia Umbria was a member of the partnership, coordinating the farms involved in the project in order to provide different raw materials residues and pruning for the mixtures. In this case liquid whey has been therefore transformed from waste into biogas as a natural fuel.

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